The investigation of regional ecology using

$2km \times 2km$ scale

botanical distribution data

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ABSTRACT

Tetrad vascular plant data from Staffordshire (VC 39), accumulated 1995 - 2009, were analysed using Two Way Indicator Species Analysis and Principal Components Analysis, explored using GIS, to examine major floristic distribution patterns. Environmental data were also examined using Redundancy Analysis.

The strongest floristic trend was a human influence axis, arranged south—north, with the south being most anthropocentric and the north having a high proportion of semi-natural habitats. Indicator species for different parts of the County showed a corresponding strong biogeographic element, with 'Southern-temperate' and 'Boreo-temperate' characteristics in south and north respectively

The next most important factor in the distribution of plant species in Staffordshire was habitat quality and richness, which separated intensively-managed farmland from areas with semi-natural habitats and from human influenced urban areas.

Environmental variables associated with the main division in the data were mainly climate and altitude and the extent of developed land. Historic field patterns, identified by Staffordshire County Council, were associated with semi-natural habitats, linking an historical landscape characterisation with vascular plant analysis for the first time in the UK.

The investigation set out to characterise and classify spatial units in terms of biodiversity importance, and to produce an objective ecological classification of the Staffordshire region based on botanical and physical features. The resulting classification characterises different areas of the County in terms of plant species composition, and has many potential applications in terms of nature conservation strategy development, targeting of resources and monitoring. A further aim was to facilitate the selection of indicator species for high quality habitats – the study has enabled revision of Staffordshire's axiophyte plant list. Both the ecological classification and indicator species will be of strategic value because the information provided is authenticated by being based on objective analysis of a wide range of data.

In Staffordshire, further work is required to develop environmental data, especially an effective dataset for hedges, while comparison of the data with historical botanical data could provide further information about the County's previous environment.

The techniques developed in the study could be used more widely to: produce of lists of key species, provide information for environmental modeling, climate change monitoring, target nature conservation activity, and to develop landscape strategies.

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CONTENTS

Tables

Figures

1 INTRODUCTION

1.1 Background

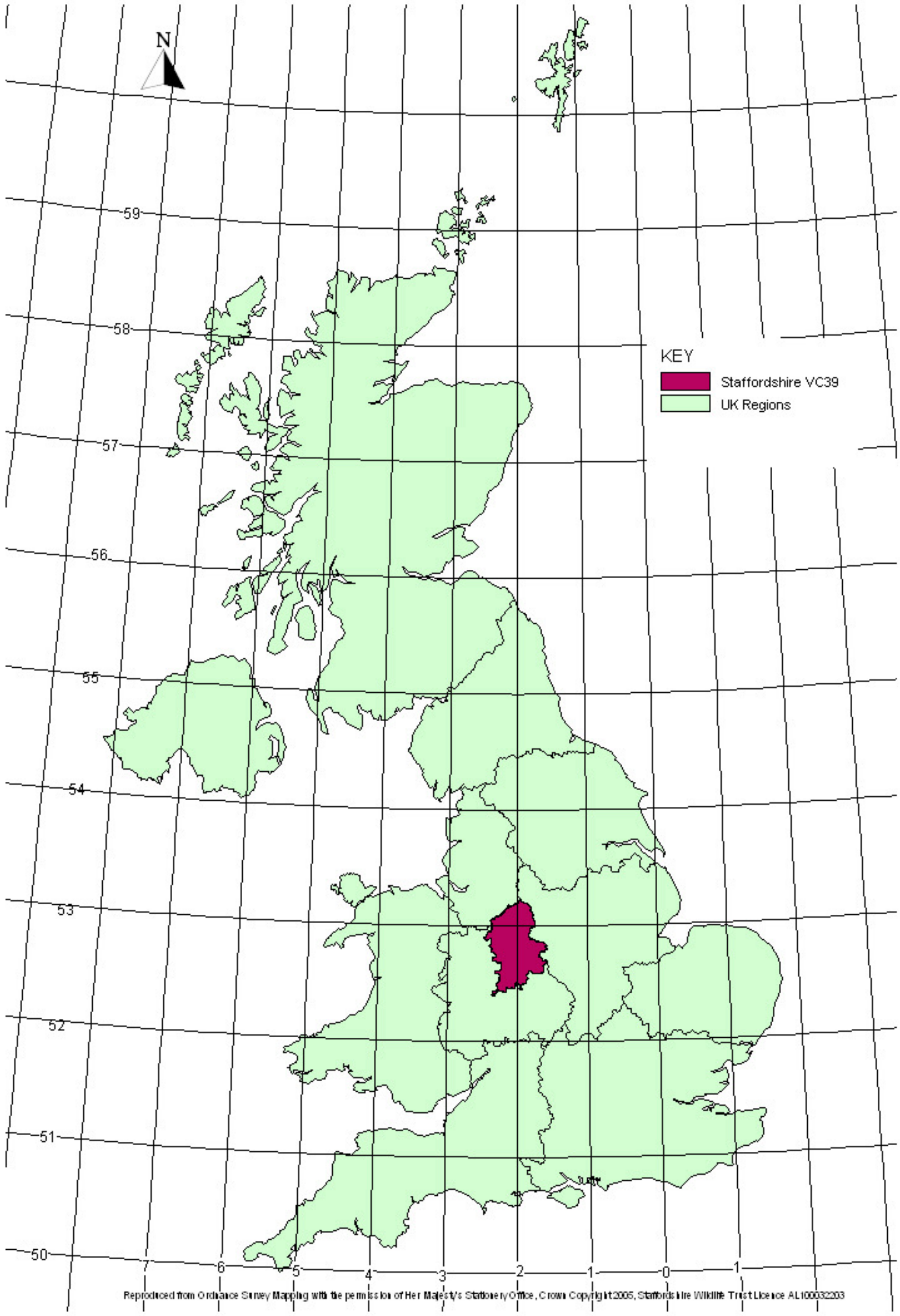
The large body of botanical data accumulated for the Staffordshire Flora Project has the potential to provide a deeper understanding of the ecology and geographically transitional nature of the Staffordshire region. The data comprises more than 200,000 records of over 2000 species collected between 1995 and 2009.

Staffordshire is of particular interest because of its geographical location (Figure 1.1). Edees (Edees, 1972) considered that its location centrally in the UK was partly responsible for the diversity of the County's flora. He cited several species normally found in the south-east, such as *Ononis spinosa* and *Thalictrum flavum*, plants of a northern distribution including *Empetrum nigrum* and *Myrrhis odorata*, distinctly western species such as *Ulex gallii* and *Umbilicus rupestris*, and an eastern species, *Hottonia palustris*, which are all found in Staffordshire

The present study sets out to interpret the ecology of Staffordshire by analysis of data collected during the Staffordshire Flora Project.

The investigation will use multivariate analysis and geographical information systems (GIS) to analyse the botanical data and their relationships with various physical characteristics of the County, such as altitude, roads, rivers, canals, land use, geology and climate. This will provide an understanding of the factors controlling floristic differentiation at tetrad level, which might have implications for parallel studies elsewhere.

Figure 1.1 – Geographical location of Staffordshire



1.2 Botanical data

The production of a modern county Flora involves the systematic large-scale collection of botanical distribution data e.g. the 'The Flora of Montgomeryshire' (Trueman *et al.*, 1995), and the 'Flora of Staffordshire' (Edees, 1972). Floras are explored in more detail in Chapter 2; the following is an outline of the processes usually used, and related work.

Usually the data are collected on a 1 km^2 (monad) or 2 km^2 (tetrad) basis and used to produce distribution maps (dot maps). The intention of such a process is to collect data in a systematic manner, with as complete (or at least as consistent) coverage of each recording unit as possible. In practice this may be affected by difficulties in obtaining access to land, differences in skill level between participating recorders and in the time expended (Rich and Woodruff, 1990). The data collected are however usually the best available, other surveys usually being site based or (exceptionally) systematic, but often only to Nature Conservancy Council Phase 1 methodology standard (2003), which tends to cause the surveyors to focus on selected key species, to the exclusion of most other taxa.

1.3 Research applications

A comprehensive and detailed study of Staffordshire's botanical data would be of use because there is now a wide range of potential applications for this work. These include the production of nature conservation strategies and targeting of future activities. Chapter 2 is an analysis of previous studies of biological data at a large scale. These have not explored fully the potential uses of large-scale data, either focusing on using relatively small data sets to produce predictive models for larger areas (Heikkinen, 1998) or to advance the understanding of the ecology of a county by use of computer ordination, for example Sinker *et al.,* (1985). Staffordshire is potentially of particular interest because it is thought to be geographically transitional (Edees, 1972).

1.4 Aims and objectives of the present study

Spatial analysis of the 200,000 records accumulated for the Staffordshire Flora Project has the potential to improve understanding of the relationships between the ecology and geography of the Staffordshire region, and to establish a baseline against which to measure biodiversity change. Analysis of the data will therefore address the following aims:

- To characterise and classify spatial units in the Staffordshire region in terms of biodiversity importance
- To produce an objective ecological classification of the Staffordshire region based on its botanical and physical features
- To determine which aspects of the relationships between plant distributions and the physical and social geography and geology of the Staffordshire region the 2 × 2 km square can be used to detect
- To determine which environmental factors are most closely correlated with the distribution of biodiversity in the Staffordshire region
- To facilitate the selection of indicator species for a range of purposes, based on the objective analysis of a wide range of data
- To support the production of nature conservation strategies, based on the objective analysis of a wide range of data.

The above aims were achieved by:

- The analysis of the tetrad data from the 1995 onwards Staffordshire Flora Project, using a range of computer analysis techniques.
- The production of datasets of environmental information at the 2 × 2km scale, which were applied analytically to improve understanding of the plant distribution data.
- The use of Geographical Information Systems to display and interpret the results of computer analysis.

2 LITERATURE REVIEW

2.1 Background

An interest in wild plants and their locations is universal and has a long documented history, for example ancient herbals from Ayurvedic medicine (at least 2000BC) and Chaldean herbalists (around 5000BC) (Bown, 1995). Probably the longest established reasons for paying attention to where plants are found and how to identify them are utilitarian, ranging from obtaining medicinal and edible plants through to collectors in search of new species for gardens. These reasons continue to the present and more recently have expanded to include crop scientists seeking to increase the genetic pool of crop varieties, for example Song *et al.,* (2003).

Naturalists have often simply logged where species occur as a form of 'stamp collecting'; this is arguably of limited use, except to other naturalists who wish to see the same plants and / or to log their own records. Information on where plants are found in a region may be published as a Flora or Atlas. Most recently published Floras have sought to provide context for the distributions of species by describing physical features of the region, and the type of habitat and location in which the species are usually found.

The emergence of ecology as a separate science in the late 1800s and early 20th Century (Warming, 1895; Cowles, 1911), meant that an understanding of how plants related to each other and to their environment became essential. This led to studies of vegetation and of the requirements of individual plants, and recognition of the fundamental role of plants in ecosystems (Tansley, 1911; Tansley, 1939; Braun-Blanquet, 1928).

Concerns about damage to the environment became widespread throughout the 20th Century. In the early part of the century, campaigning organisations and naturalists' groups became popular, resulting in the setting up of nature reserves in Britain from the 1920s onwards. Originally, the purpose of many reserve purchases was the protection of birds, however many reserves are now established for broader habitat conservation and it is usually the plant communities that are used to describe, define and evaluate the habitats (Ratcliffe, 1977).

In the latter part of the 20th Century, there also emerged a considerable body of nature conservation legislation and policy at international, national and local levels. This eventually also led to the setting up of grants to support nature conservation work, including agri-environment grants. At all levels, legislation, policy and grant aid are in place to protect habitats as well as species, and it is usually the case that the habitats are defined in terms of their plant species composition.

Nature conservation practitioners need to monitor change caused by external factors, such as climate change or agricultural intensification, and change caused by conservation action such as management or habitat creation. Information from monitoring is used to press for better legislation or grants, or to check the efficiency and effectiveness of nature conservation work. For the majority of habitat monitoring plant species can be used, and this work is often relatively cost-effective compared to using animal species.

Habitat and species monitoring tends to be expensive in terms of manpower because of the need to work in the field. Remote techniques have been used, but habitats such as grassland, or woodland ground flora need to be examined directly. Where it is not possible to cover an entire area, modelling techniques may be used. Data from samples may be extrapolated to provide information on a wider area using other information, such as physical data. It is also possible to use data on a limited range of species to indicate wider trends.

2.2 Floras

2.2.1 UK Flora

The 'New Atlas of the British Flora', and its accompanying CD-ROM, which were published in 2002, give distribution maps for over 3000 flowering plants and ferns (Preston *et al.*, 2002). It marked a considerable advance in technology from the third edition of the 'Atlas of the British Flora', which gave black and white dot distribution maps of species (Perring and Walters, 1983).

The 'New Atlas' uses colour to distinguish between native and alien populations and the accompanying CD provides extensive additional data to the printed version. The distribution data are based on 10 km squares, and are mapped for three periods: pre 1970, 1970 - 1986 and 1987 – 1999. Each species is described in terms of its ecology, its distribution, origins and changes to UK populations. This information is important source material for the requirements of any UK plant species. For example, *Ribes alpinum*:

> A dioecious shrub of limestone woods, rocky hedgerows and streamsides, often trailing over small cliffs and steep rocks in shaded places. It is also grown in gardens, and is found naturalised on roadsides, waste land and as a relic of cultivation. …
>
> Native (change +0.45). Even within the areas where it is considered native, the distribution of this species has been obscured by escapes from cultivation as the species is widely planted for hedging or ornament.

In the Peak District, some thought therefore needs to be given to distinguishing between *Ribes alpinum* as a native species and as a garden escape. In Staffordshire, most populations are part of scrub on the sides of limestone valleys, and the map (Figure 2.1) shows far fewer records on the Staffordshire side, as opposed to the Derbyshire side. This fact demonstrates that even at the 10km square scale, distribution data can give information about a species, but also that the amount of information is limited and requires the more detailed level of recording which is now general in vice-county Floras.

Figure 2.1 – *Ribes alpinum* – native populations shown in blue

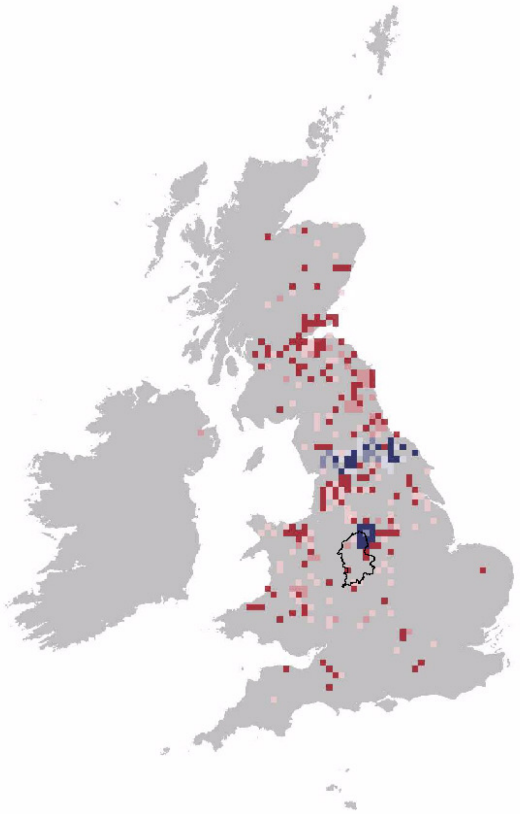


*Figure taken from 'New Atlas of the British and Irish Flora CD-ROM (Preston *et al.*, 2002, Ribes alpinum) , Staffordshire boundary superimposed in black.

2.2.2 Vice-county and other local Floras

2.2.2.1 Relationship between floras and ecology

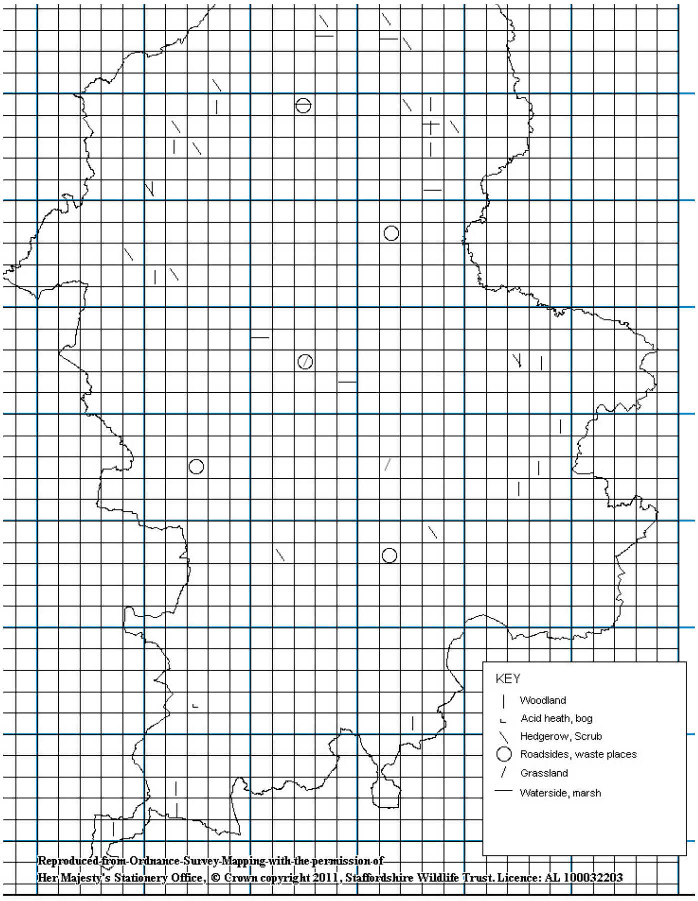
The relationship between Floras and ecology is examined by M O Hill (2003 p.321) in 'Using data from local floras for ecological research', a paper in which he states *"…there is rather little flow of information between ecologists and flora writers."* Probable reasons for this are discussed, including incompatibility of scale, where most ecological studies involve smaller units than floras, and where landscape scale factors are most likely to affect plant distribution as far as floras are concerned.

There are notable exceptions to this lack of connection between ecology and local floras. Prior to readily available computer analysis, for example in 'A geographical handbook of the Dorset flora', Good (1948) analysed his dataset from 7500 sampling stations using 'by eye' comparisons, as did the Flora of Derbyshire (Clapham, 1969), which concentrated largely on plants with distributions that link to geology, such as *Polemonium caeruleum,* which was found on limestone. However, computing makes statistical analysis and detailed assessments of large datasets much easier. In the 'Ecological Flora of the Shropshire Region' (Sinker *et al.*, 1985) and 'The Flora of Montgomeryshire' (Trueman *et al.*, 1995) computing techniques have been used to analyse data. In the latter, Hill considered that the agreement between the coincidence map for ancient woodland species and the distribution of ancient woodland sites is "Particularly impressive…" (Hill, 2003 p.324).

Hill also noted that the scale of floras at 1 km squares or greater, means that gradients of variation tend to be either obvious without analysis, or difficult to interpret if not obvious, with examples from Berkshire (Bates, 1995) and northern Finland (Heikkinen *et al.*, 1998; Heikkinen, 1998).

Hill concludes *"…distributional data from local floras remain rather intractable and difficult to use. Probably this is because the standard methods of analysis seek general patterns. … Present methods of numerical analysis are inadequate."* (Hill, 2003 p.328).

Figure 2.2 – Example of map* similar to those in 'A Computer Mapped Flora'



*This is a map using artificial data designed to illustrate the approach used in Warwickshire to show the distribution of a species and its primary habitats (Cadbury *et al.*, 1971). Data of this type is not available for Staffordshire.

2.2.2.2 Warwickshire

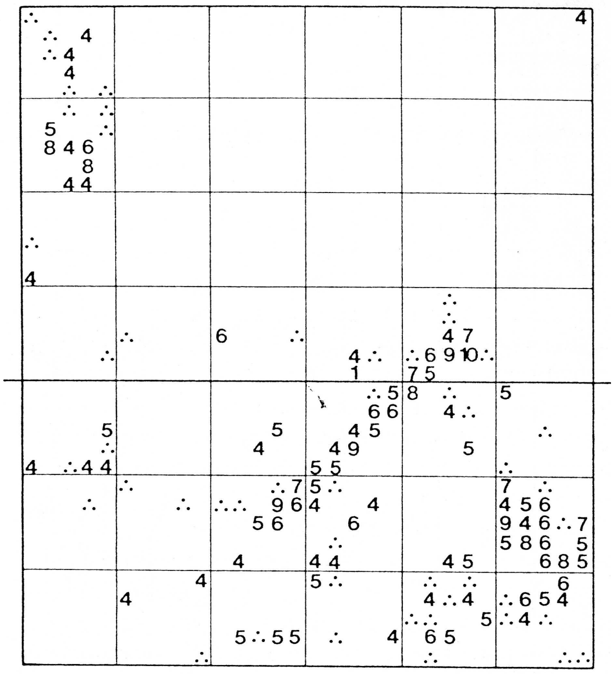
The first county flora to use computing to map distributions of species was 'A Computer Mapped Flora – A Study of the County of Warwickshire' (Cadbury *et al.*, 1971). Data for this flora had been collected in considerable detail so that it was possible to map species with the major habitat or habitats within which it had been recorded. The computer mapping used symbols to represent nine broad habitat types. A symbol, or combination of symbols, showed the most frequent habitats for a species within each tetrad, an example of this technique using artificial data appears in Figure 2.2. In addition, an approximate guide to the frequency for each habitat within a tetrad was also given. Transparent overlays for various physical features, temperature, woodland and urban areas were also provided.

An example map on page 447 of 'A Computer-mapped Flora', for *Veronica montana*, shows its association with woodlands and scrub. It is clear from the map that it is very rarely associated with other habitats.

The Flora also included useful lists for the most commonly occurring species in each habitat, for example rivers and streams had *Nuphar lutea, Apium nodiflorum* and *Rorippa nasturtium-aquaticum* as the three most common species, while canals had *Potamogeton pectinatus, Potamogeton crispus* and *Potamogeton perfoliatus* as the most common species.

This level of detail is rarely collected for county Floras and consequently this innovative approach does not appear to have been repeated in its entirety, even though computer mapping is now greatly advanced and widely available. It also requires that recorders wish, and are able, to distinguish habitats, which is not always the case.

Figure 2.3 – Coincidence map of woodland species in Shropshire*



(b) *Old woodlands on base-rich soils*

Campanula trachelium	Listera ovata
Carex strigosa	Orchis mascula
Epipactis helleborine	Paris quadrifolia
E. purpurata	Sorbus torminalis
Festuca altissima	Tilia cordata
Hordelymus europaeus	Vicia sylvatica
Lathraea squamaria	Viola reichenbachiana

*Figure taken from 'Ecological Flora of the Shropshire Region' (Sinker *et al.*, 1985, p.157)

2.2.2.3 *Shropshire*

The 'Ecological Flora of the Shropshire Region' (Sinker *et al.*, 1985) uses computer ordination techniques (see Section 4.3) to analyse stand data from across the County for each broad habitat type. The size of stand varies according to the type of habitat from 1 m^2 for grassland to 25 m^2 for woodlands. This analysis provides a scientific background to the habitat chapters, and could be replicated elsewhere for comparison. Data with this level of detail has not been collected for Staffordshire, however parallels might be expected with a neighbouring county, and at least some of the indicator species emerging from the Shropshire analysis might be expected to occupy similar positions in Staffordshire ecology.

In Shropshire, coincidence mapping of species was also used, possibly for the first time. This technique involves the selection of species that are characteristic of certain habitats and combining their distribution maps, indicating where few or many of the selected species coincide. An example for "old woodlands on base-rich soil" is shown in Figure 2.3. Three bands of high-scoring species can be seen, two of which coincide with geology or soils that are not immediately apparent from the species or habitats present. Therefore, the authors conclude the map "is telling us something that we do not already know about the regional environment" (Sinker *et al.*, 1985, p.159). The present study does not use coincidence mapping, rather it attempts to show trends such as these by using analysis of the entire dataset.

2.2.2.4 Montgomeryshire

'The Flora of Montgomeryshire' (Trueman *et al.*, 1995) contains an analysis of physical features and land cover, using data from published maps and from satellite imagery. Data derived from Ordnance Survey maps are presented as dot maps at tetrad resolution, with data derived from satellite images presented at 1 km square resolution. Chapters on soils, climate, geology and land use are related to the vegetation and plant distributions, and the chapters are drawn on in describing the vegetation of the County (Chapter 7).

Computer ordination was used to analyse data and is described in Chapter 11, 'Analysis and Interpretation of Plant Distribution Data'. The species used in this analysis were restricted by leaving out the ubiquitous species ('A' list species), and most of the very rare species ('C' list species), and the data further reduced by leaving out incomplete tetrads. The resulting dataset contained 587 species and 501 tetrads.

Data analysis showed that there was a relationship between species richness and mean altitude (Figure 2.4), with areas of higher mean altitude having lower species diversity. The highest diversity was associated with either base-rich habitat or a diversity of habitats, usually including urban habitats.

Using computer ordination (again omitting the very common 'A' species), the main gradient present in the data was related to altitude, as shown in Figure 2.5. Indicator species analysis identified a similar gradient, with *Juncus squarrosus, Nardus stricta, Erica tetralix* and *Molinia caerulea* as indicator species characteristic of moorland found in higher altitude areas, and *Ribes uva-crispa* characteristic of lowland areas.

Further details from the indicator species analysis identified altitude as a continuing influence, with an 'upland fringe' group of tetrads, indicated by species such as *Polygala serpyllifolia* and *Viola palustris,* emerging from the lowland group. This group further divided into a small group of 25 tetrads with wet moorland species, such as *Myosotis secunda*, and a 'more marginally upland fringe' group, with lowland species as indicators.

The remaining lowland groups of tetrads divided into those with predominantly aquatic habitats, indicated by *Glyceria maxima*, and those without (*Senecio sylvaticus* and *Sanicula europaea*).

The upland groups of tetrads divided into a group suggesting a more exposed landscape, shown by *Eriophorum vaginatum* and *Empetrum nigrum*, while a group of less exposed tetrads is indicated by shade and lowland plants, such as *Lapsana communis* and *Circaea lutetiana.* Further division of the exposed group was explained, with a group of tetrads influenced by poor drainage (shown by species such as *Achillea ptarmica*), the remaining tetrads by presence of rock exposures (with species such as *Solidago virgaurea*).

Figure 2.4 - Relationship of species richness and mean altitude in Montgomeryshire*

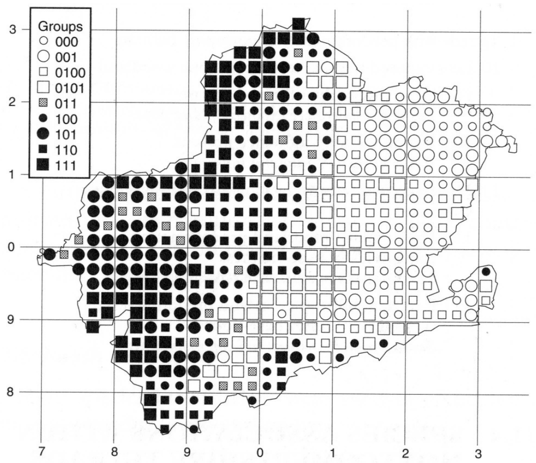


Fig. 11.10 Summary of Geographical Distribution of TWINSPAN classification of tetrads.

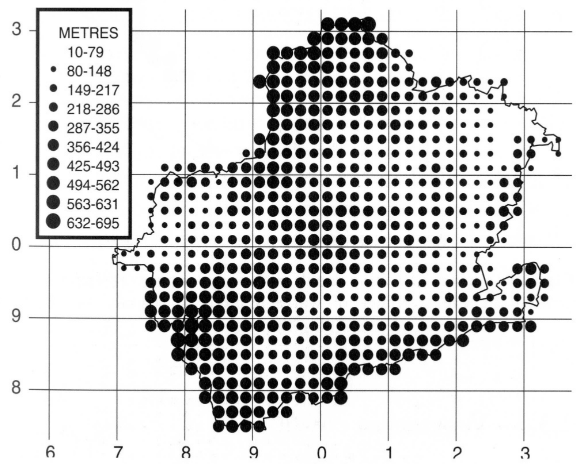


Fig. 2.4 Average of maximum and minimum altitude recorded for each tetrad in the vice-county. The altitudes are divided into ten classes, represented by increasing symbol size.

**Figures taken from 'The Flora of Montgomeryshire' (Trueman et al., 1995, pp.29 & 207) Solid symbols, groups 100 to 111 are upland groups*

Figure 2.5 – Indicator species analysis and altitude in Montgomeryshire*

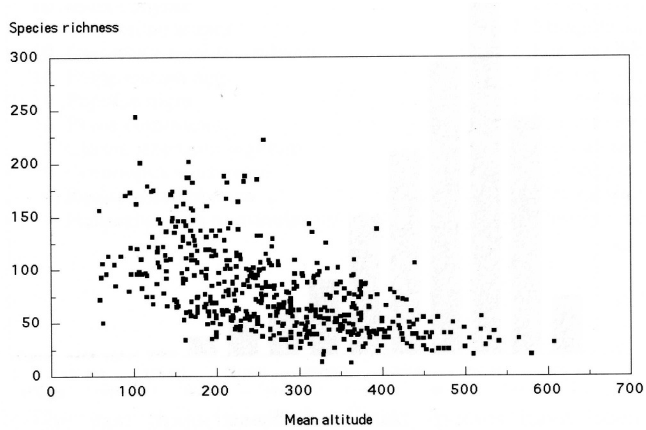


Fig. 11.3 Scatter plot showing the relationship between species richness and mean altitude of tetrads.

**Figure taken from 'The Flora of Montgomeryshire'* (Trueman *et al.*, 1995, p.208)

2.2.2.5 Staffordshire

The only modern flora for Staffordshire is the 'Flora of Staffordshire' by E S Edees, which covered a period of recording by members of the North Staffordshire Field Club from 1956 to 1972 (Edees, 1972). It omitted casuals and garden escapes, which was done to save space. This was unfortunate in a county such as Staffordshire, which has experienced rapid industrial and residential expansion, and where these types of species could provide information about change. Another space saving, imposed by the publisher, was to restrict the published distribution maps to 200 species. Edees provided an alphanumeric code for the 10 km square in which each species was found, and the total number of records for the species, however this is difficult to read and the detailed information is lost. For most species, Edees described the current distribution and history of recording:

For example, *Impatiens capensis,(*Edees, 1972, p.66*)*:

> Abundant near the mill at Great Haywood, where it was first recorded for the county by P. P. Thornton in 1941, and in many places along the canals between Great Haywood and Tamworth Y, Z, b, f-g, n, 12.*

*Letters indicate 10km squares, e.g. Z is SK02, and 12 is the total number of records of the species

In some cases the description was much more terse, e.g. *Scrophularia auriculata,* (Edees, 1972, p.128) was described as "River and canal sides: common in the south: K, (M), P-X, U-x, 184. Pitt, 1794."

Although the published Flora had only 200 distribution maps, Edees had been in the process of producing a much more comprehensive set. Some of these are complete and ready for publication, and others are still in pencil. The set of maps has been digitised and is now in the Potteries Museum, adding an additional 750 maps to the 200 published ones.

Edees also provided a brief outline of the vegetation of the County, with descriptions of the geology, relief etc., with illustrative maps. Although not detailed, to a large extent these still apply today and have been drawn on for the current study, and for preparation of the new Staffordshire Flora (see Section 3.1).

2.3 Electronic data

Since around 1980, species data has been recorded electronically as well as on paper. This work is usually coordinated by the Local Records Centre (LRC) for an area (typically a county). The LRC for Staffordshire, Staffordshire Ecological Record (SER), for example, holds over 1.2 million records of species for a wide range of taxa from fungi to mammals (Slawson, 2010). Records are entered into a database, usually RECORDER 6 (Ball, 2002), which can produce distribution maps for each species. It is often possible to access this information remotely through the website of the individual LRC, or through the National Biodiversity Network Gateway, which holds over four hundred datasets, with over 50 million records from across the UK (National Biodiversity Network, 2010).

Another development has been the use of Geographical Information Systems (GIS), which store and manipulate spatial data. One of the most widely used GIS programs is MapInfo, which has been extensively used in the present study to generate information, store information and to display results.

GIS allows instant comparison between say, a 1:10,000 Ordnance Survey map, and the distribution of a species or group of species. Map data is essentially in one of two forms, raster data or vector data. Raster data is where the program displays a picture, but is unable to read information from that picture. Most inexpensive map data is in this form, and it is this type of data that Staffordshire Wildlife Trust holds licences for.

Vector data is generated in a form that the program can read and interpret; it is much more expensive than raster data.

A full set of colour aerial photographs for the County are also held by SER(Blue Sky, 2003); these are held in GIS as a seamless layer and can be viewed with any other geographic layer.

2.4 Analysis of change

Data from flora recording schemes and similar initiatives would appear to be a useful measure of change in the environment. Vice county boundaries do not change and the recording unit is usually the tetrad, so there tend to be datasets for different periods for the same area using the same recording unit. However there may still be considerable difficulties to be overcome before making comparisons between recording periods. This is because recorders and recording effort may change. Using historical data is often more problematic because it is usually more patchy than modern data, although techniques have been devised for dealing with these problems (see below).

The use of data from local floras was explored by Walker (2003), who examined local floras, including second editions, supplements and checklists, from 1660 to 2002. In England, he found that 85% of vice counties had two or more local floras or checklists. The trend for recording in 10 x 10km units or smaller only dates from 1960, previous recording schemes were based on lists for sites or counties were divided into areas for which lists were produced.

Many floras now include lists of extinct species, which can be used to indicate change. Walker looked at floras for 11 counties in southeast England with lists and noted the broad habitat type for each of the extinct species. He concluded that the causes of change included drainage and habitat loss (species such as *Parnassia palustris, Carex dioica* and *Utricularia minor*). However, rare arable plants (for example, *Arnoseris minima*) and localised species of acid grassland and bog such as *Anagallis minima, Hammarbya paludosa* and *Hypochaeris glabra* had also been lost.

To illustrate the possibility of comparing dissimilar early work with modern records, Walker (2003), compared data from the early Flora of Northamptonshire (Druce, 1930) and the modern Flora (Gent and Wilson, 1995) for the Orchidaceae and Cyperaceae. He acknowledged that:

> …even extremely thorough recorders … did not always cover the various parts of the county with equal intensity … As a consequence their qualitative statements of abundance area likely to be biased … (Walker, 2003, p.312)

Despite this, the results of a comparison are interesting as he concludes:

> Although rather crude this approach shows that, despite the increase in recording activity … 49 species (61%) appear to have become less common … whereas only eight species (10%) appear to have increased … (Walker, 2003, p.312)

Attempts have been made to apply statistical methods to the comparison of historic and modern data. McCollin *et al.,* (2000b) compared the two Floras of Northamptonshire (Druce, 1930; Gent and Wilson, 1995). Druce's comments on the relative abundance of each species were ranked into eight categories from 'very rare'(1) to 'very common' / 'abundant' / 'ubiquitous' (8). These ratings were compared with the 1995 pentad records (5 km x 5 km) for each species. Changes were calculated as standardised residuals from the linear regression line for the whole dataset to achieve an indication of relative change since 1930. Species that had declined the most (those greater than 2 standard deviations below the regression line) included aquatic species, such as *Hottonia palustris* and *Oenanthe fluviatilis*, and arable species, such as *Ranunculus arvensis, Agrostemma githago* and *Torilis arvensis*. To some extent, these reflect the findings of Walker on county extinctions (the 11 counties he examined included Northamptonshire) with aquatic and arable species among the fastest declining.

Where sets of data exist in grid format (tetrad etc.) for an area for different periods, measuring change should be a simpler task. However, biases in this type of data are recognised (Rich and Woodruff, 1992; Rich, 1998). Telfer *et al.,* (2002)developed a method to minimise biases in this type of data, using a linear regression model, similar to that used by McCollin *et al.* Only grid cells that have been recorded in both periods are used to eradicate the effect of different cells, or different numbers of cells, being visited. The result is an index of relative change in range size for each species. A more complex model was used by Rich and Woodruff (1996), using a correction factor to allow for increased recording effort.

The Botanical Society for the British Isles (BSBI) operates various monitoring schemes, one of which involved a survey of 429 systematically chosen sample 10 km squares (known as hectads) in Britain and Ireland (Rich and Woodruff, 1990). It was concluded (Le Duc *et al.*, 1992) that these data could be used to estimate the probability of finding species in other areas of the country using mathematical modelling, with data from county floras to validate the estimates.

2.5 Institute of Terrestrial Ecology Surveys

The vegetation and land cover of the British countryside have been the subject of extensive surveys by the Institute of Terrestrial Ecology (ITE), the Countryside Survey, in 1978, 1984, 1990, 1998 and 2007. The methodology for this work incorporates a vegetation classification system for the whole of Great Britain, the Countryside Vegetation System (CVS). The CVS differs from the NVC (Rodwell, 1991 - 2000) in that the sample plots are placed at random, while the NVC samples homogenous stands of vegetation. The purpose of the CVS is different from the NVC, being designed to describe the wider countryside and to monitor vegetation change (Bunce *et al.*, 1999a).

The CVS used computer analysis of over 13,000 samples, which were grouped into 100 vegetation classes using TWINSPAN (Hill, 1979b). These were then analysed using DECORANA (Hill, 1979a) and grouped into eight aggregate classes, according to their relative positions on the first four DECORANA axes. These were crops / weeds, tall grassland / herb, fertile grassland, infertile grassland, lowland wooded, upland wooded, moorland grass / mosaic and heath / bog. The three main axes correlated to soil nutrients, disturbance / shade and soil moisture, with for example, crops / weeds corresponding to high soil nutrients and low shade / high disturbance. By contrast, upland woodland corresponded to low soil nutrients and high shade / low disturbance.

The resulting body of data from the various surveys has enabled detailed analysis, both of the vegetation and of the characteristics of individual species. In 1999, the ITE published a table of 're-calibrated' Ellenberg indicator values for 1791 taxa occurring in Britain, including all native species (Ellenberg, 1979; Hill *et al.*, 1999), for light, moisture, pH, nitrogen and salt requirements. Values for species not previously described by Ellenberg were added, and all values were adjusted to apply specifically to species' requirements in Britain. These re-calibrated values are derived using data from the Countryside Survey 1990, the first four volumes of the NVC, additional published material and field experience. In many cases, species behave differently in Britain than in Central Europe and it is helpful to have the specific British values for many plant ecology applications.

This work was expanded upon considerably with the publication of 'PLANTATT - Attributes of British and Irish Plants: Status, Size, Life History, Geography and Habitats'(Hill *et al.*, 2004), which brings together information from various published sources, the ITE database and personal observation from the authors' and others' experience in the field.

The overriding objective of the Countryside Survey is to record and measure change in the British Countryside. 'ECOFACT Volume 3 – Causes of change in British vegetation' (Firbank *et al.*, 2000) reported on changes between the surveys of 1978 and 1990, which included intensification of agriculture, increase of broadleaved and coniferous woodland, loss of hedges, reduced cutting of road verges and continuing drainage of agricultural land. It was considered that agricultural extensification schemes, such as Environmentally Sensitive Areas had not been established for long enough to have started to show effects. It was possible to show that acidification decreased between 1978 and 1990. 'Countryside Survey: UK Headline Messages from 2007' (Carey *et al.*, 2008) continued this work, with *Urtica dioica, Rubus fruticosus* and *Crataegus monogyna* becoming more abundant between 1998 and 2007, indicating that land management is reducing, while the most rapidly decreasing plant species included mainly wetland plants.

The Countryside Survey also resulted in the development of the computer package MAVIS (Modular Analysis of Vegetation and Interpretation System) (Smart, 2000) (See 4.3.4).

2.6 Scale

Studies often refer to the use of the 'meso-scale' when describing work on data for units that are greater than a few metres square, so it is helpful to know whether tetrad scale fits into the mesoscale for the purposes of comparison. Heikkinen (Heikkinen, 1996, p.151) attempted to define the meso-scale as lying somewhere between "fine-scale ecological investigations" and "broad-scale biogeographical studies" in a study of the species-richness of the Kevo Nature Reserve in Finland. Gould (2000) mentioned a sample size range of between 0.5 to 10^4 km^2. Heikkinen indicated that the use of the meso-scale in units of between 500 m x 500 m to 2 km x 2 km would be of "considerable interest in the conservation and strategies for land-use of medium-sized areas" (Heikkinen, 1998, p.133). Most of his studies were carried out at either 500 m x 500 m or 1 km x 1 km scales. In practice most studies at the mesoscale appear to be in the range 500 m x 500 m (Luoto *et al.*, 2001) to 5 km x 5 km (Korvenpää *et al.*, 2003; Bruun *et al.*, 2003). Most recent county-wide botanical mapping projects in the UK have used the 2 km x 2 km 'tetrad' unit, which is within the ranges given for the mesoscale.

2.7 Species characteristics

Our understanding of datasets for plant species is greatly increased if the characteristics of individual species are known. The most widely used are approaches by Grime (2007), who described plant strategies for British species depending on how they respond to stress (S), competition (C) and disturbance (R), and Ellenberg (Section 2.5 above).

Both CSR and Ellenberg values have been used to interpret plant distribution data at the mesoscale. McCollin *et al.,* (2000b) used such values in their comparison of data from the 1930 'Flora of Northamptonshire' (Druce, 1930), with the 1995 'The Flora of Northamptonshire and the Soke of Peterborough' (Gent and Wilson, 1995). McCollin *et al.,* used Ellenberg indicator scores, climate change indicators (Preston and Hill, 1997) and habitat and dispersal characteristics from Grime *et al.,* (1988). Species that had increased since 1930 were associated with higher Ellenberg nitrogen scores, and hence an increase in the trophic status of the landscape. These values were used for a comparison of ten sites within Rome by Fanelli *et al.,* (2006), who found that urban and suburban sites differed in both CSR and Ellenberg species characteristics. British floras do not appear to have used this approach in detail yet, which could prove helpful in interpreting data.

2.7.1 Alien status of species

According to Pyšek *et al.* (2004) in a critical review of the terminology from across Europe, De Candolle (1855) first became aware of the importance of biological invasion, followed by Darwin (1859). A terminology for describing alien plant species was devised by Thellung, (1918 - 1919) and the most widely used European terminology including the term 'archaeophyte' is the one adopted by Holub and Jirásek (1967).

'The New Atlas of the British and Irish Flora' (Preston *et al.*, 2002), described what status alien species have in terms of how well established they have become in Britain and Ireland. They considered that archaeophytes and neophytes are introduced species that are present in the wild as introduced populations, an archaeophyte having been established before 1500, and a neophyte after that date. Casuals in this context are not established species, but those considered as requiring constant re-introduction.

Pyšek *et al.* (2004) noted that the definitions used by Preston *et al.* were different from those commonly used in Europe. European terminology separates intentional introductions from unintentional ones, and gives a far more complex list of definitions, for example, archaeophyte and neophytes are sub-categories of xenophytes (artificially introduced species). Hemerophytes are intentionally introduced species, such as crop species. In Britain, it may be helpful to consider these further definitions where there are both agricultural areas and urban areas. For example, the presence of oilseed rape (*Brassica napus* ssp *oleifera*) might be expected in both urban areas as a ruderal and rural ones as a crop escape, and a detailed characterisation of accompanying species might clarify the situation. A species might also have both 'native' and 'alien' status within a county, according to Pysek's suggested definitions, for example in Staffordshire *Carex pendula* occurs naturally, but has been introduced to some woodlands, and has also escaped from gardens in places.

2.7.2 Critical species

The Botanical Society for the British Isles (BSBI) has developed the concept of axiophytes (Botanical Society for the British Isles, 2010); these are plants that are thought to be indicators of habitats that are important for conservation. The BSBI explains that axiophytes should be assigned by first drawing up a list of habitats of conservation importance. Axiophytes are defined by the BSBI as:

> Species that are 90% restricted to habitats of conservation importance
>
> Species recorded in fewer than 25% of tetrads in a county
>
> Species that are known from at least three sites in the county (Botanical Society for the British Isles, 2010, Projects, Axiophytes)

The concern here is that, having decided that certain habitats are of importance, then a list of axiophytes is intended to be used to determine the condition and / or importance of such sites. This is close to a circular argument, and may be better approached by examining all known species and habitat records for correlation, as is suggested by the current study.

The axiophyte concept could be considered to be an extension of the concept of ancient woodland indicator species (Peterken, 1974) which is now well-established as a method of determining the age of woodlands. Peterken used data from known ancient woodlands to produce his list – the potential problem with the use of axiophytes is that their selection is based on potentially subjective assumptions about the species and the 'importance' of habitats used for their selection (point (a) above). One objective of the present study could be to facilitate the selection of indicator species for a range of purposes, based on the objective analysis of a wide range of data.

2.7.3 Indicators of urban areas

Roy, Hill and Rothery (1999), studied BSBI monitoring data from 785 sample tetrads across Britain compared with data from the Land Cover Map of Great Britain to discern the effects of urbanization on the flora. They found that the number of native species was fewer in urban areas, but overall richness did not change statistically because the proportion of non-native species increased. Urban areas notably lacked woodland species such as *Holcus mollis, Lonicera periclymenum* and *Oxalis acetosella*. Species with a strong positive association with urban land cover were found in less than 25% of all tetrads, except for *Sagina procumbens*.

In an examination of urban plant distribution, Hill, Roy and Thompson (2002) noted that the above study had not produced as clear a definition of urban species as hoped. They therefore compared species data for quadrats (varied in size from 1 m x 1 m to 14 m x 14 m) sampled in urban areas with existing calculated values for a range of attributes for each species. This enabled indices to be generated for other attributes including urbanity (proportion of urban land found in the vicinity of the species), xenicity (proportion of associated neophytes) and annuality (proportion of associated annuals). The two latter characteristics were concluded to be good urban indices that are simple to determine. The urban flora of the areas studied in central England was then characterised and a list of urban indicator species devised. It was concluded that this approach could be expanded to cover a wider area if more data were used.

2.8 Analysis of mesoscale data using environmental variables

For each recording unit where botanical data is gathered, corresponding environmental data, such as altitude or underlying geology may be inferred or directly gathered from a number of sources. For larger sample areas, such as tetrads, some variables, e.g. soil pH, can be difficult to ascribe because they can vary considerably. Other variables, of less relevance in recording small samples (such as quadrats), may be considered for larger samples, for example the proportion of land occupied by buildings.

Scientific investigation of plant distribution patterns requires some quantification of the likely environmental influences. For example, if altitude is thought to play a role in the distribution of a species then it will be necessary to compare the distribution of that species with altitude values for each unit sampled. This type of information is readily available from Ordnance Survey data. Other sources, such as meteorological data, geological data are readily available.

It may also be necessary to develop a system for assessing a variable where the variable does not form part of an established dataset. For example, Staffordshire County Council devised a system for assessing the possible age and origin of field patterns, using current and historical map data (Staffordshire County Council, 2008). This information was then used to place fields, or blocks of fields into classes, such as 'early assarts' used for example to indicate a system of field boundaries of medieval origin that had probably been derived from blocks of woodland. While these were derived with archaeological rather than nature conservation uses in mind, the implication is that this information may relate to species composition. This could be directly in terms of hedgerow species, or indirectly where longer-established semi-natural grasslands might be expected in older field systems.

2.8.1 Nature reserve / protected area studies

Various studies of data at the mesoscale include those carried out by Heikkinen (1996; 1998) and Heikkinen *et al.* (Heikkinen *et al.*, 1998) on the Kevo Nature Reserve in northern Finland, using a 1 km grid. The first of these used statistical modelling to look at patterns of species richness using environmental variables, while the second examined ecological gradients within the data. Environmental variables were used in both studies which included latitude / longitude, altitude, physical features such as rivers and cliffs and solid and drift geology. Altitude (or altitude related variables) was the main factor affecting both species richness and the main variation in species distribution patterns. The second ordination gradient in the species data was mainly related to the presence of mires. However, Heikkinen *et al.* noted that "…*geographical and geological variables explain relatively little of the species distributional patterns.*" and that although the mesoscale had been useful in providing a lot of information about plant-environment relationships other factors operating at a finer scale also had an effect. They concluded "…*the grid size used fails to detect accurately the ecological patterns of the species present.*" (Heikkinen *et al.*, 1998, p.123).

In Norway, Bar and Loffler (2007) examined an area of high plant and bird diversity, a nature reserve and designated RAMSAR site (convention on wetlands signed in Ramsar, Iran 1971) (c. 160 hectares), in order to develop ecological indicators for the future management of the area. They used ordination techniques such as Canonical Correspondence Analysis (Section 4.3.3) to correlate plant species data (5 m x 5 m samples) and environmental variables derived from aerial photographs and other data such as pH and hydrology from on-site measurements. The main ecological variables were extracted and the vegetation classified into complexes based on the effects of these variables. Although based on more detailed plant data, smaller samples and a much smaller area, the use of Canonical Correspondence Analysis to classify the vegetation data might have some parallels in the study of tetrad data for a larger area.

2.8.2 Wider areas

Gould (2000), used remote sensing and vegetation mapping with recorded species data to produce a model of likely species-richness for an area of the Central Canadian Artic. He concluded that remote sensing was more effective at predicting species diversity than analysis of a vegetation map of the area, but that using both sets of data in the model meant that a high proportion (79%) of the variance in species richness could be explained. The greatest diversity was found in areas of greatest landscape heterogeneity.

A study of plant species richness in the Austrian Alps using a grid of 5 x 3 arc minutes (34 – 35 km^2) was undertaken by Moser *et al.,* (2005). They used variables that included evapotranspiration, temperature, soil types, geology, proximity to lakes and rivers and measures of heterogeneity based on land-use, and found that climatic variables were the most important predictors of species richness. As might be expected, similar results were found in an Italian region of the Alps by Marini *et al.,* (2008), who examined vascular plant richness with environmental variables which included climatic, land cover, heterogeneity and spatial variables. Marini *et al.,* considered that their work reflected the water-energy model of O'Brien (1998; 2006) which found that woody plant richness on a geographic scale (Africa, USA, China and South America) depended on climate-based, water-energy dynamics.

Qian (1999), who examined vascular plant diversity across North America found that diversity increased with decreasing latitude, and from east to west. The paper concentrated on geography and prehistoric development, rather than climate, however this diversity is probably at least partly climate related because the north of North America (tundra and subarctic climates) is colder than the south (subtropical and warm desert), and rainfall is higher (up to 1459mm per annum) on the east (Lewis and Winkleman, 1996).

In agricultural south-western Finland, Luoto *et al.,* used satellite data and elevation data to model plant diversity. They found that 'hotspots' of total plant diversity were found in river valleys, associated with habitat diversity (Luoto *et al.*, 2002). Hotspots of rare species were also found in river valleys, associated with semi-natural grasslands and deciduous forest on steep slopes.

Vanderpoorten *et al.,* (2005) looked at an area of Belgium (1760 km^2) in terms of bryophyte conservation. Redundancy analysis was used to determine which environmental factors correlate to bryophyte diversity. The proportion of military land, steep slopes and presence of broadleaf woodland were most correlated with species diversity and with species of conservation value.

2.8.3 Urban studies

The above are studies that focus on rural areas, or do not appear to consider human activity or urban areas as major factors. By contrast several studies have concentrated on urban areas, including one by Kent *et al.,* (1999) in Plymouth, which used two way indicator species analysis and canonical correspondence analysis with environmental variables. They found that age / stage of development was a major factor in the species composition of an area, with the presence of remnants of semi-natural vegetation also being important.

In a study of wasteland in Paris, Muratet *et al.* (2007), compared species richness, indigeneity and rarity for 986 sites using age of site, land use information and physiographic features. They found that species richness depended on size of site (larger sites were richer) and age of site, with the optimum being 4-13 years. Similarly, Zerbe *et al.,* (2003) found that species richness in Berlin was greatest between the city centre and the outskirts where there are large parks, urban forests and large urban wastelands, and concluded that species richness is therefore associated with larger sites. These areas mainly comprise residential areas developed in the 1920s and 1930s that are characterised by large open spaces and remnant gardens with fruit trees, so species richness appears to be associated with areas of around 90 years old. However, the Berlin study was based on areas rather than individual sites, so it is not possible to make a direct comparison between this and the Paris study.

2.8.4 Implications for present study

It is clear from the above that the significance of different environmental variables changes with the context and scale at which they are used. In alpine areas both Moser and Marini (2005; 2008) found that climate was the important factor, as had O'Brien (2006) when working on continent-scale data, and probably Qian (1999). In the Kevo Nature Reserve, a smaller area (729 km^2), which encompasses both alpine, and river valley areas, the main determining factor was altitude. In urban areas, findings were similar, with age and size of site being most important in determining diversity.

Not all studies examined habitat diversity or landscape heterogeneity so further comparisons become difficult because it is not possible to predict whether this would be a more important variable than other ones that were used.

Nearly all of the above studies concentrate on species diversity, sometimes with additional work on rare species, and most refer to nature conservation as the driving force for the need to pin down plant diversity. However, many animal species, for example solitary bees and wasps (Smith, 2002) require suitable substrate, microclimate and seasonal nectar supply, while others such as butterfly species depend on a few plant species, for example *Boloria selene* (small pearl-bordered fritillary) feeding on *Viola* species (Thomas, 1986). Nature conservation therefore probably has more need for measures of habitat quality and for more complex information. Possibly a flexible approach is needed with plant data being used with other information to help provide information for wider work.

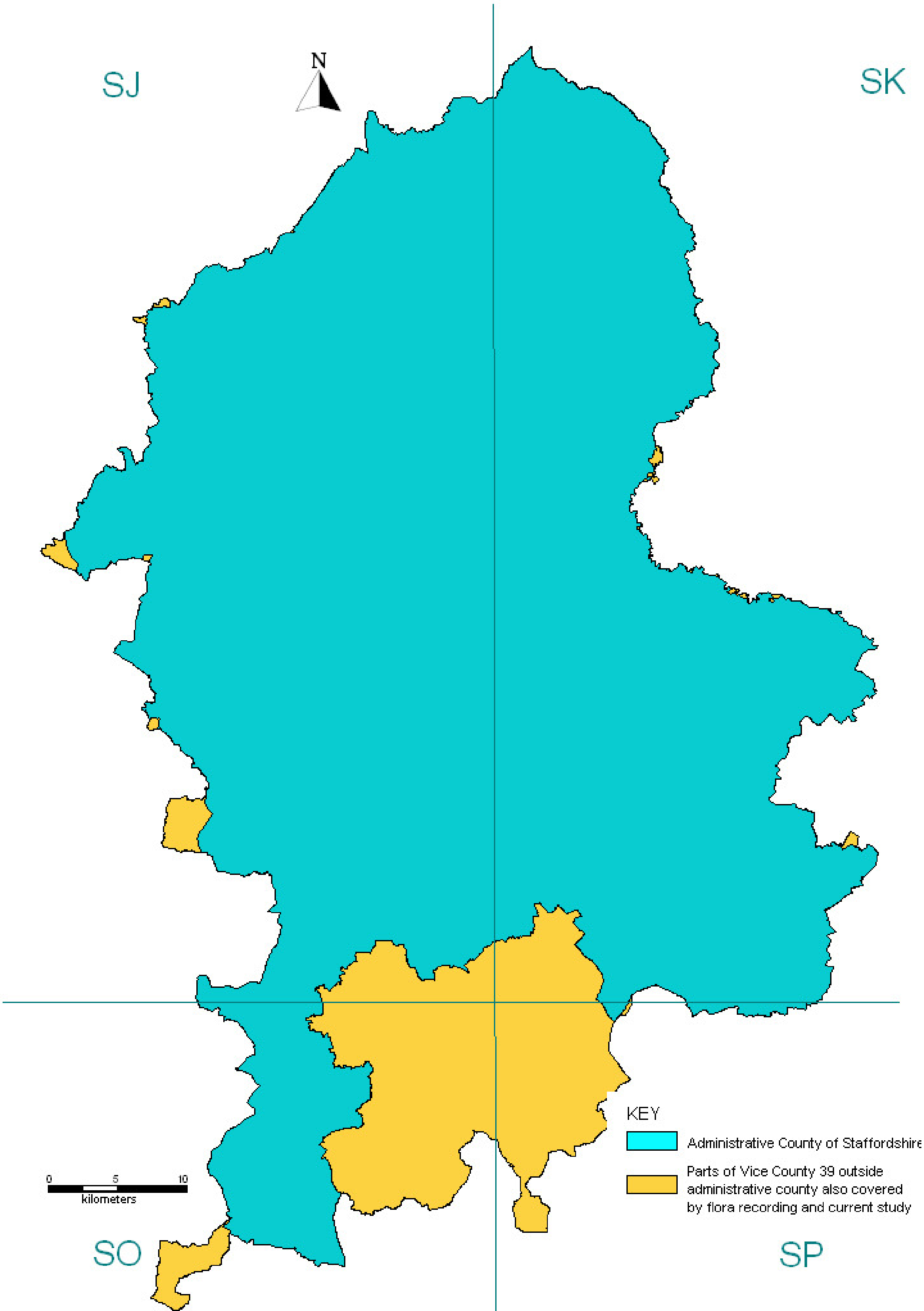
3 STAFFORDSHIRE FLORA AND BACKGROUND

3.1 Flora Project

3.1.1 Introduction to Flora project

The Staffordshire Flora Project started in 1998 when interested botanists met to discuss the need for a new flora covering Staffordshire. The previous flora (Edees, 1972) was somewhat out of date and the Checklist of Flowering Plants and Ferns (Hopkins, 1985) mainly provided information about the relative abundance of each species. The area covered combines the current administrative County of Staffordshire with the Watsonian Vice County Staffordshire 39 (Dandy, 1969), taking the outside boundary of the combined area (Figure 3.1).

Figure 3.1 – Area covered by Staffordshire Flora, showing OS 100km grid



3.1.2 Flora data

The data collected for the Staffordshire Flora consist of species records for vascular plants for each tetrad (2 km x 2 km square). It was intended to record each taxon only once per tetrad, although in practice multiple records did occur because of the need to visit tetrads more than once (see 2.3 and 2.5 below). No attempt was made to determine abundance within tetrads. The data used were in the form shown below (Table 3.1), with '1' representing presence in a tetrad, and the species name abbreviated:

Table 3.1 - Example of data

Tetrad	Abiealba	Abiegran	Abienord	Abieproc	Acanmoll	Acanspin	Acercamp	Acercapp
SJ74X	1						1	
SJ74Y							1	
SJ74Z							1	
SJ75F								
SJ75K								
SJ75Q							1	
SJ75R								
SJ75V							1	
SJ75W							1	
SJ80A								
SJ80E								
SJ80F		1		1			1	
SJ80G							1	
SJ80H							1	
SJ80I								

3.1.3 Recording process

Around 70 individual volunteer botanists recorded data for the flora. Volunteers were initially assigned tetrads largely on the basis of proximity to their places of residence in order to reduce travel needs. Volunteers were encouraged to visit 'their' tetrads several times during the year, and many volunteers recorded over more than one year.

It was also agreed to incorporate data from the County Habitats Surveys (Radford *et al.*, 1995-2000; Cadman *et al.*, 2004 - present), as this was felt to represent a large body of useful botanical data.

3.1.4 Data management

Collation of data was undertaken by entering species records into a RECORDER 3.4.5 (Ball, 2002) database. RECORDER was designed to hold species data for all British taxa, and contains reference lists for most taxa. The information that it is designed to hold is limited, and it does not handle detailed site descriptions well, for example. In Staffordshire, data such as site descriptions are held in separate databases and in a Geographical Information System.

3.1.5 Data validation

Quality control of the data has been achieved by the Botanical Society for the British Isles Vice County Recorder checking all records. 'Rare' species to be recorded at 100 metre accuracy were defined using the 1985 Checklist (Hopkins, 1985). During the Flora recording process, rare species were then either checked in the field or by use of herbarium specimens, which were subsequently lodged with the Potteries Museum and Art Gallery in Hanley.

The 'completeness' of recording for each tetrad was also checked, using:

a) a comparison of the recorded list for each tetrad with a list of the commonest plants in Staffordshire to see whether any were missing – as these species were expected to be ubiquitous absence would indicate under-recording.

b) a comparison of the total number of records for a tetrad with other tetrads with similar features. For this a map was used, with symbols denoting ranges of numbers of records – this enabled comparisons, so for example all tetrads within Stoke-on-Trent might be expected to have similar totals recorded.

Where a tetrad was thought to be under-recorded the recorder was asked to continue recording, or another recorder was sent out to produce additional records. This was in line with research (Rich and Woodruff, 1992), which showed that different expert botanists often recorded different species and that the efficiency of recording increased considerably when recording was shared between different individuals for each area.

3.1.6 Additional data

Large datasets from the County Habitats Surveys (Radford *et al.*, 1995-2000; Cadman *et al.*, 2004 - present) and various other Staffordshire Wildlife Trust surveys were incorporated into the Flora. This required linking the site-based information to tetrads in the Flora database. Where a site crossed the boundary between tetrads, the botanical data could not be ascribed to either tetrad and were excluded from the Flora dataset. Where there was only a small overlap a judgement was made as to whether a site could be included or not.

3.1.7 Sites designated for nature conservation

An understanding of the ecology of the County may also be informed by examining descriptions of designated sites, although the designation process tends to have concentrated on more 'natural' habitats, for example those formed and maintained by traditional land management techniques. In particular, designation processes largely ignore post-industrial sites; habitats which are now recognised as important in the UK Biodiversity Action Plan (UK Biodiversity Partnership Standing Committee, 2007) as 'open mosaic habitats on previously developed land'.

A number of statutory designations apply in Staffordshire, depending on how important the site is for nature conservation. The most widespread of these are Sites of Special Scientific Interest (SSSIs), designated by Natural England under Section 28 of the Wildlife and Countryside Act (1981). The designation may be for plant or animal assemblages or for geology, or for a combination of features. SSSIs may have further designations such as National Nature Reserve (four in Staffordshire).

Non-statutory designations include Sites of County Biological Importance (SBIs), which are selected by a panel of ecologists in Staffordshire using published guidelines – (Webb *et al.*, 2006). The Guidelines allow sites to be selected for plant or animal assemblages. In practice, nearly all sites are of predominantly botanical importance because of the difficulty of gathering data for animal species. In the Black Country area, the equivalent term is Site of Importance for Nature Conservation (SINC); SBI is used in the present study as a term for both SBIs and SINCs.

One of the uses of flora data might be to predict where site survey effort should be concentrated, by analysing correlation between flora data and existing designated sites, and possibly by deriving lists of indicative plant species. Care would be needed, however, because flora data already takes account of information from site surveys, so some correlation would be expected.

4 METHODS

4.1 Botanical data

Species data were edited to provide a manageable dataset and to remove species that had probably been unevenly recorded. Species used in the analyses are listed in Appendix A, with notes indicating where changes to the original data have been made. All species names are as in Stace (2003).

Where it was thought that segregates would have been recorded consistently, they were kept as subspecies, for example *Lamiastrum galeobdolon* subsp. *argentatum* and *Lamiastrum galeobdolon* subsp. *montanum*. In other cases, the segregates were combined into one set of records and duplicates were deleted in order to maintain the consistency of one record per tetrad, for example *Aconitum napellus* subsp. *napellus* was combined with *Aconitum napellus* agg.

Hieracium species were retained as they only include confident records by specialists working on the Flora. *Hieracium* sp. was deleted to avoid duplication with this data. Various Hieracium Section records were also deleted; these were very few in number.

Single records of ornamental trees traceable to arboreta were deleted, as were genus only records, for example *Chenopodium* sp. The latter occur when site surveyors are working out of season and are from site-based records only, not the flora project. These have not been included in the Appendix.

Species with only one or two records were checked against the database and deleted if the record was thought to be unreliable. These species records originated at Staffordshire Wildlife Trust and had not been checked by the County Recorder; they could usually be attributed to data entry errors.

Species were abbreviated using an Access database, which identified duplicates and produced an eight letter shortened version, for example *Agrostis stolonifera* becomes Agrostol. Some species were abbreviated manually, for example *Polypodium vulgare* (Poldvule) and *Polygala vulgaris* (Polgvuls) since they do not follow this pattern because of duplication. Other frequent examples were *Carex panicea* (Carepani) and *Carex paniculata* (Carepata), *Rumex acetosa* (Rumeacet) and *Rumex acetosella* (Rumealla), and *Melilotus officinalis* (Melioffi) and *Melissa officinalis* (Mssaoffi). Hybrids were usually given the hybrid name used by Stace (2003), such as *Rosa* x *dumalis* (Rosaxdum).

Data were transferred from RECORDER (Ball, 2002) via an ACCESS database, a series of ten EXCEL spreadsheets, and the CanoMerge and WCanoImp utilities of Canoco for Windows (ter Braak and Šmilauer, 2004) into TWINSPAN for Windows Version 2.3 (Hill and Šmilauer, 2005a) and Canoco for Windows for processing.

4.2 Environmental variables methodology

4.2.1 Use of Explorer maps

Ordnance Survey 'Explorer' series maps were used to derive the environmental variables tabulated in Appendix B. The maps, which are produced at a scale of 1:25,000, show a range of features, such as woodland cover and field boundaries. Data were cross checked with aerial photographs (Blue Sky, 2003) where necessary. Allotments stand out on aerial photographs but are not always shown clearly on the maps, for example. All urban areas were checked for allotments, as these are emerging as an important source of species records (J. Cale, I.C. Trueman pers. comms.). All data were collected on a monad (1 km square) basis to enable finer detail to be recorded. To derive data for the tetrad (2 km x 2 km square) the total was calculated.

4.2.1.1 Percentage cover estimate

For each type of land cover, for example, agricultural land, cover was estimated visually for each monad. To ensure this process was accurate, a transparent grid was produced, through which the area covered could be read. One monad is 100 hectares. The monads were then added to give one figure for the total.

4.2.1.2 Linear features

Linear features such as roads, railways and canals were recorded as estimated linear length in metres. These figures were then added to give a single figure for the tetrad.

For roads, 'A' roads and motorways were recorded together as 'Major roads' and all other metalled roads were recorded as 'other roads'. Previous studies have mainly used blanket categories. In a study of Chicago one of ten land cover classes used by Iverson and Cook (2000) was "*Highly developed urban land that is dominated by impervious surfaces and buildings*", while Muratet *et al.* (2007) used 'transport' to include roads, railways and parking lots in Paris. Luck and Wu (2002) used 'roads' in a case study of Phoenix, Arizona without distinguishing types of road. Kent *et al.* (1999) used a category of 'main road' in Plymouth, derived from OS maps. In their analysis of urban land cover in the West Midlands, Owen *et al.,* (2006) used four categories of road: 'A' roads, 'B' roads, minor roads and motorways among a set of 25 variables. These were used to produce a classification of land types, rather than being used in analysis of ecological data.

Using two categories of road was therefore considered the best way of distinguishing the largest and busiest roads from others, while limiting the data to a manageable volume. The intricate networks of small roads serving housing estates that were not coloured on the maps were not measured to save time; it was considered that the housing category would represent these adequately.

Disused railways were placed in a separate category from active ones because the habitats present tend to be somewhat different and management is usually non-intensive (or non-existent) on disused railways.

Rivers and streams were only included where they were delineated with a double line. This was because a distinction could not otherwise be made between straightened streams and drainage ditches, which all appear as single blue lines on the maps.

4.2.1.3 Agricultural land and average field size

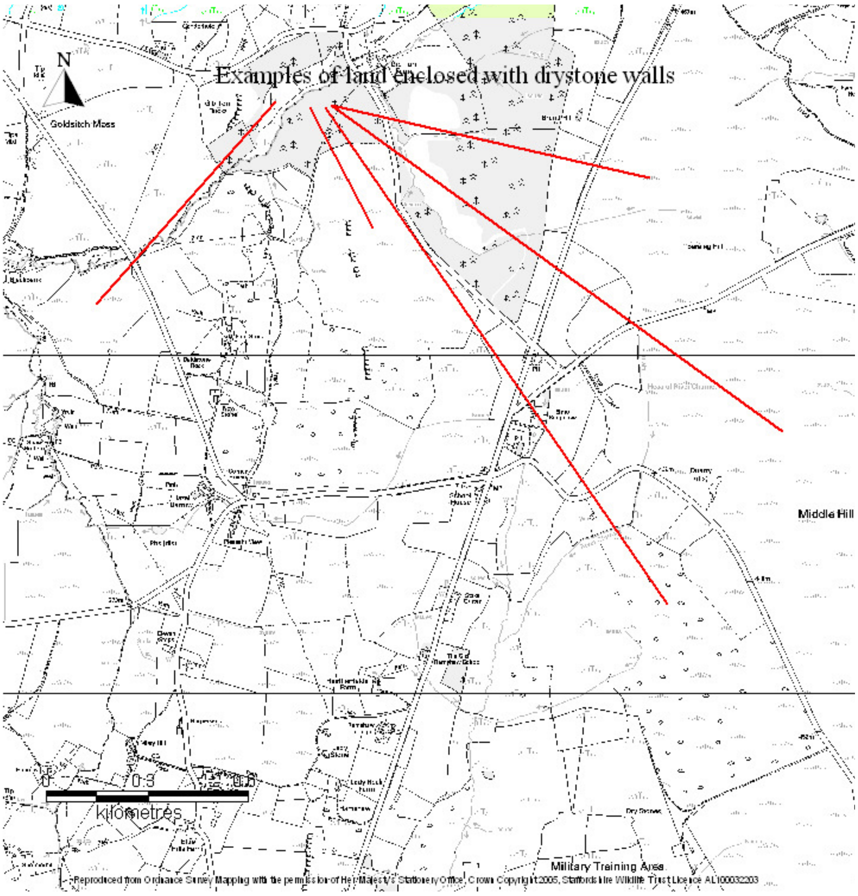
The number of fields in each monad was also counted; this was then used to calculate an average field size using the estimated cover in hectares of agricultural land:

For example, for a tetrad with 292 hectares of agricultural land and 136 fields the average field size is 2.15 hectares. This means that for a tetrad with no agricultural land, for example urban areas, this value is null. If entered as zero into the Redundancy Analysis, this would mean that these areas appear to have very small fields. To allow for this, the average value without these tetrads was calculated and then the average value was entered into all tetrads with a value of zero. This is the solution suggested in the CANOCO manual (ter Braak and Šmilauer, 2002), as missing values are not allowed for in the data formats. Strictly speaking, these missing values should be allowed for in any statistical analysis of the variables because they represent missing degrees of freedom (Lepš and Šmilauer, 2003).

4.2.1.4 Moorland

In Staffordshire, areas of non-intensively managed land in upland areas may be enclosed in large blocks (Figure 4.1). This can be seen within the Staffordshire Wildlife Trust landholding at Black Brook near Leek, to the centre north of Figure 8 (OS ref SK016643). This land has more of the characteristics expected of open moorland elsewhere in the Leek Moors area, such as around Axe Edge (OS ref SK029707; not shown in Figure 4.1). It was therefore decided to distinguish this land from large intensively-managed fields by including it with open moorland. It was considered that this would help to ensure that field size calculations gave a reasonable representation of the situation in any given area. The land was identified using a combination of Ordnance Survey symbols (for bracken, heath and rough grassland) and local knowledge. To some extent there will be a correlation between these areas and altitude, but there are also many large improved grassland fields at high altitude that are used for silage.

Figure 4.1 - Enclosed moorland



4.2.1.5 Minimum altitude

The minimum altitude for each tetrad was noted from the Explorer maps. Broadly, this usually follows the maximum altitude, so in the upland the minimum altitudes are greater than in the lowlands. Canoco for Windows will take larger figures as more important than smaller ones, which is not desirable for minimum altitude, where areas of low altitude are probably of more interest. The minimum altitude was therefore subtracted from 600, so that low altitudes had greater values than higher ones for data processing purposes.

4.2.2 Other data sources

4.2.2.1 Open water

A GIS dataset was created using OS Mastermap vector data, copied and divided up along tetrad boundaries. Tetrad areas then calculated using a MapInfo query and copied into the Excel spreadsheet.

4.2.2.2 Ancient Woodland Inventory

GIS layers showing ancient woodland were downloaded from the 'Nature on the Map' section of Natural England's website and divided up along tetrad boundaries using MapInfo (Natural England, 1999b; Natural England, 1999a). Tetrad areas were then calculated as for open water and copied into the Excel spreadsheet.

4.2.2.3 Sites of Special Scientific Interest

Section 3.1.7 details site designations applicable in Staffordshire. The technique used was as for the Ancient Woodland Inventory.

4.2.2.4 Local Wildlife Sites

Site boundaries for sites from the Staffordshire administrative County (Sites of County Biological Importance) and from the Black Country (Sites of Importance for Nature Conservation) were divided along tetrad boundaries and the areas calculated in MapInfo. These data were then entered into the Excel spreadsheet and combined as Local Wildlife Sites (Section 3.1.7).

4.2.2.5 *Geology and soils*

Maps for solid geology and soils, based on the originals in the 'Flora of Staffordshire' (Edees, 1972) were digitised and brought up to date in consultation with the Staffordshire Regionally Important Geological and Geomorphological Sites Group. They were also extended into parts of the vice county not covered by Edees' maps by use of the more detailed British Geological Survey (BGS) digital data maps. The hectarage of each type within each tetrad was used, so tetrads may have more than one type of geology and soil. Drift geology data from BGS maps was used to generate a similar dataset of tetrads areas for each type. These maps include a category 'drift geology not mapped', which appears to indicate a lack of data, rather than an absence of drift (shown as 'no drift').

4.2.2.6 *Climate*

Maps for annual average values calculated over the years 1971 – 2000 for mean temperature, days of snow lying, days of ground frost, sunshine duration, minimum temperature, rainfall amount and maximum temperature are provided on the Met Office website (www.metoffice.gov.uk, 2010). These are not of particularly high resolution, but give a clear indication of how climate varies across the County and the resolution is broadly compatible with the tetrad scale. Data from these maps were therefore used to provide a dataset of climate environmental variables for entry into CANOCO. Where a tetrad crossed between two or more categories, the one with greater coverage was chosen.

4.2.2.7 *Historic field patterns*

Staffordshire County Council (2008) has produced data, which show the origin of field patterns. Eight categories of field pattern have been described and mapped, covering the administrative County wherever there are remaining fields. These categories, in order of field age are: early assarts, early small irregular fields, early small rectilinear fields, miscellaneous floodplain fields, paddocks and closes, piecemeal enclosure, 18^{th} and 19^{th} century planned field systems, post 1880s reorganised fields. There is no data for the Black Country, however data is lacking for most other urban areas too because the field pattern is absent or obscured, so this was considered to be reasonably consistent.

4.2.3 Data processing

Results from the Explorer maps were compiled using a straightforward 'Microsoft Access' database. A 'crosstab' query was then processed to produce a table giving the final data for each tetrad (as summarised in Appendix B).

The data were then copied into Excel, amalgamated with data from other sources (Appendix B) and used for input into the data analysis process via the WCanoImp facility of Canoco for Windows (ter Braak and Šmilauer, 2004).

4.2.4 Mapping

All maps in the current study are produced using MapInfo, unless stated otherwise. Where environmental variables as above were mapped, and a wide range of values applied to the data used, for example average field size ranged from 0.2 to 19.6 hectares, in most cases the 'natural break' option was used to select the ranges mapped. This is designed to produce easily readable chloroplethic maps, that is coloured or shaded maps, with an optimum balance between information and readability (Jenks and Caspall, 1971).

4.3 Methods for data analysis

4.3.1 Background

Data were analysed using two computer programs developed specifically for ecology: TWINSPAN TWo-way INdicator SPecies ANalysis (Hill, 1979b) and Canoco for Windows (CANOnical Community Ordination) (ter Braak and Šmilauer, 2004). The programs are designed to show trends and relationships within data, which then require interpretation by the ecologist. The programs may analyse stand (tetrad in this case) and species data only (TWINSPAN) or may also enable the inclusion of environmental variables in the analysis (CANOCO).

Stand / species data is typically analysed in two ways:

a) species data can be analysed according to which stands species occur in
b) stand data can be analysed according to the species contained in each stand.

Analysis involves either ordination or classification or both:

a) ordination – species or stands are arranged along an axis so that species or stands are closest together when they are most similar
b) classification – stands are placed in groups which have similar species composition.

In reciprocal ordination, species are ordinated according to the stands they occur in and stands are ordinated according to the species that occur in the basis of the classification of the stands. Ordination and classification are purely numeric – the programs do not recognise ecological relationships. Species are assigned numbers so that data is read in the form of a large matrix, with the species numbers along one side and stand numbers along another.

A measure of how much of the variation in the data is explained by any division or axis is given by the **eigenvalue**. Each ordination is constructed so that it explains as much of the variation as possible, so that eigenvalues decrease as the ordination progresses (Lepš and Šmilauer, 2003). In linear ordination methods, the total variability is 1, that is the sum of eigenvalues for all possible axes is 1 (Lepš and Šmilauer, 2003). Ter Braak and Šmilauer indicate that eigenvalues can be low, especially in abundance or presence-absence data, and that despite this, the information provided by ordination can still be useful (ter Braak and Šmilauer, 2002).

4.3.2 TWINSPAN

In the present study TWINSPAN for Windows (Hill and Šmilauer, 2005a), a program designed for classifying biological data made up of species and stands has been used to sort stands (tetrads) into groups of similar types, with their accompanying species. TWINSPAN can be described as a polythetic hierarchical method of classification (Hill *et al.*, 1975). Polythetic methods use data on all species present at each division, rather than just considering one species. Hierarchical methods divide data into smaller and smaller 'lots' by dividing groups into sub-groups and so on. In TWINSPAN the basis of the classification is a series of reciprocal ordinations.

TWINSPAN ordinates stands into two groups at the first level, the division represents the 'centre of gravity' along the strongest trend in the data. Stands on one side will have a score that is less than the mean, and those on the other will score more than the mean. Therefore, numbers of stands on either side of the division may differ. This is termed the 'primary ordination' (Hill and Šmilauer, 2005a).

TWINSPAN then identifies, by a further 'indicator ordination', up to fifteen species for each division that have a strong affinity for either group; these are termed indicator species. They are rarely entirely absent from the other group, but will have a much weaker association with it by comparison. Each species has a score for the group it is in which equals the number of stands it occurs in divided by the total number of stands for the group. These scores are used to define the final groups of the ordination referred to as an improved or 'refined ordination' in the TWINSPAN user guide (Hill and Šmilauer, 2005b). This usually means that the final groups are slightly different from the original division. The stands in each of these two groups are then re-ordinated separately to elucidate the strongest trend, which is used to divide the group into two further groups and so on in reiterations of the primary, indicator and refined ordination process.

In the present analysis, the default number of seven indicator species was used for ease of interpretation and display in the dendrograms. Selecting a different number is likely to change the resulting ordinations, however it is to be expected that the fundamental trends in the data will be elucidated with seven indicators; the original use of TWINSPAN allowed for five indicator species (Hill *et al.*, 1975).

TWINSPAN also lists preferential species for each group; these have twice the chance of appearing on one side of the ordination as the other. Preferentials have a weaker association than the indicators, but may still be of help in explaining the ordination. Only species with greater than 20% frequency on either side are listed. If the two groups are of uneven size, then a preferential may occur in more stands on its non-preferential side. For example, a species occurring in 2 out of 3 stands in one group (indicator species score 0.67), and 3 out of 12 stands in the other (score 0.25).

A list of non-preferentials is also given by TWINSPAN, these species are balanced between the two groups; only those with greater than 20% frequency are listed.

The results may be represented as a 'family tree' or dendrogram, showing for example three divisions (eight end groups). At each division, an indication of how different the data in the two groups are is given by the eigenvalue. If the two groups were different in all respects then the eigenvalue would be one.

TWINSPAN simplifies abundance data for species (usually recorded on a scale of 0-10) into a smaller range of categories (typically 5, numbered 0-4), which are treated as if they are separate species and are called pseudospecies in the analysis. Since Staffordshire Flora data is not recorded using any measure of abundance, rather just presence / absence, the default values ascribed by TWINSPAN were used which gave a pseudospecies level of 1 to all species present.

The data was processed several times using TWINSPAN with different size constraints applied to tetrad selection. Initially all tetrads, even small fragments were included, however this meant that the poor species diversity of small tetrads appeared to influence their distribution in the final ordination. This 'edge effect' was lost once the minimum area within a tetrad was above 100 hectares, or a quarter of the tetrad. After this, selecting tetrads with a larger minimum size appeared to have little influence on the results in terms of the number of tetrads in each end group, their geographical distribution, or the indicator or preferential species. It was therefore decided to use a minimum size of 100 hectares as a cut-off for partial tetrads.

4.3.3 CANOCO

In the present study Canoco for Windows version 4.53 (ter Braak and Šmilauer, 2004) has been used to investigate trends in the data by the ordination of species and stands along axes. It was used to examine trends in the data collected about the County's characteristics (environmental variables). It was also used to examine whether trends can be explained by the consideration of these environmental variables such as altitude. 'CANOCO' is used throughout instead of 'Canoco for Windows' for simplicity.

CANOCO is a suite of analysis methods that can be used to "provide insights into the structure of biological communities and into the impact of natural and human-induced environmental disturbances on biological assemblages" (ter Braak and Šmilauer, 2002, p. 11). The suite includes both ordination and multiple regression methods to identify trends or axes. All data are used on each axis, but each consecutive axis ignores the main trend from the previous axis / axes so that the axes are theoretically orthogonal.

The place of every species and stand on the axis is determined by similarities and differences between the species composition of stands. The axis can often be shown to correlate with an environmental variable, such as light – shade. The first axis of variation accounts for the largest proportion of variation in the data, and is therefore usually the easiest to interpret. Subsequent axes account for reducing proportions of the variation, meaning that the underlying environmental reasons become more obscure and results become progressively more difficult to interpret.

If the data being examined consist simply of species and stand data, or similar, then the ordination is referred to as unconstrained ordination or indirect gradient analysis. Environmental variables, for example climate data, may be used alongside indirect gradient analysis to aid interpretation of the results, but do not affect them. Where the analysis is carried out to show only those patterns in the species data that are explained by the environmental variables then this is constrained, or canonical, ordination, known as direct gradient analysis.

CANOCO offers two types of analysis, based on different ordination models, which are selected depending on how the data are thought to be responding (ter Braak and Šmilauer, 2002). If there is a gradient to which the species are responding more or less linearly across the data then this is said to be a linear response. This results in a straight-line graph when abundance of species is plotted against the influencing variable.

Alternatively, the species may be responding to environmental optima, giving a unimodal response, that is, a normal curve when plotted, with the centre of the curve representing the optimum. CANOCO incorporates a test for whether the responses are predominantly linear or unimodal. Linear responses are best analysed by Principal Components Analysis (PCA), unimodal ones by Correspondence Analysis.

Table 4.1 - Types of analysis in CANOCO*

Response models	Indirect	Direct	Hybrid
Linear	Principal Components Analysis (PCA)	Redundancy Analysis (RDA)	hRDA
Unimodal	Correspondence Analysis (CA)	Canonical Correspondence Analysis (CCA)	hCCA
Unimodal (detrended)	Detrended Correspondence Analysis (DCA)	Detrended Canonical Correspondence Analysis (DCCA)	hDCCA

** Taken from ter Braak and Šmilauer (2002 ,p.88)*

In both the indirect and direct analysis for the present study, the response appeared to be linear, so Principal Components Analysis (PCA) and its direct counterpart Redundancy Analysis (RDA) were used, rather than the other options that assume that the data has a unimodal response. Hybrid methods (right hand column) produce, say two, canonical axes (constrained analysis), followed by uncorrelated analysis of the data which addresses the residual variation not explained by the first (two) axes. Hybrid methods are not used in the present study.

Principal Components Analysis

Principal Components Analysis may be based on a covariance or a correlation matrix. For species analysis a covariance matrix is usually used where species are weighted by their variance. When analysing data such as environmental variables, the correlation matrix is usually used. This standardises the data, by which is helpful when the data contain various different units of measurement.

Scores from the PCA can be used to produce scatter diagrams that show the position of species, stands and / or variables along two of the axes. The scaling of the diagram can be changed to focus on species or stands or they can be equal (symmetric) depending on which is of interest. In these scatter diagrams species and environmental variables are shown as vector arrows, showing the direction of their influence, with the length of arrow indicating how strong that influence is. In the covariance scatter diagram, the length of the arrows reflects the standard deviations of species. Where the correlation matrix is used, the length of arrow is a measure of fit with the ordination diagram.

If environmental variables are used alongside the data in PCA, they do not influence the primary ordination of species and stands. However, regression vectors are calculated for the environmental variables after the primary ordination; these can then be displayed to aid understanding of the scatter plot.

Redundancy Analysis

Redundancy Analysis (RDA) is a constrained form of PCA (Lepš and Šmilauer, 2003). Redundancy means 'explained variance' in the context of multivariate analysis, where the relationship between the responses and the explanatory variables is examined at the same time. Both PCA and RDA calculate scores for stands and regression coefficients for species on each axis, however in RDA the sample scores are constrained by the explanatory variables as well.

4.3.4 Environmental variables

Each individual environmental variable was tested separately using the Monte Carlo permutation test in a Redundancy Analysis to eliminate the variables that were not significant ($p<0.01$). Stepwise selection was not used because the test is too tolerant overall when applied repeatedly (ter Braak and Šmilauer, 2002; Blanchet *et al.*, 2008).

Collinearity was checked using the Variance Inflation Factor (VIF). The VIF is a measure of the correlation between any one variable and all the others. Greater than 20 is considered to be a large VIF (ter Braak and Šmilauer, 2002). A variable with a high VIF is closely correlated to other variables, and the higher the VIF, the less the contribution the variable makes to the regression equation. A totally collinear variable, that is one that coincide entirely with another, has its VIF set to 0, and its regression coefficient and t-values are also set to 0. Normal VIFs are greater than 1, except where variables have been designed to be entirely uncorrelated (for example in an experiment) when their VIFs would all be 1 (ter Braak and Šmilauer, 2002). Blanchet *et al.,* (2008) in a study of forward selection, suggested using the VIF to indicate which collinear variables should be removed before running a global test.

Variables that were significant ($p<0.01$), and not collinear, following the two above analyses were then used in joint tests, which judge the significance of all variables jointly. Two tests: one for the significance of the first ordination axis, and one for the relation between the species and all variables were used. The first null hypothesis of the both tests is that species and environment are not related (ter Braak and Šmilauer, 2002). The second test can detect all types of relationship between species and the environment, and is termed an 'omnibus test'.

4.3.5 MAVIS

Data for preferential species from the TWINSPAN analysis was entered into the 'plot analyser' program MAVIS (Smart, 2000). For each species, a '% cover' figure was calculated by dividing the number of tetrads in which it occurred by the total number of tetrads in the end group, and multiplying by 100. This is a somewhat artificial use of presence / absence tetrad data to generate a 'percentage cover' for TWINSPAN groups, however it does allow some indicative Grime (2007) and Ellenberg (1979) values to be presented.

The 'add groups' function of MAVIS was also used, where the number of tetrads in which a species occurred was divided by the total number of tetrads in the end group, and multiplied by 5 to give a constancy value. This constancy value is the one with five classes used by Rodwell (1991 - 2000). In this, frequency of a species refers to how often it is found between different vegetation stands, so for example a species found in nine out of fifteen stands will have a frequency of 3. Frequency does not take into account how much of a species is found in a stand, and this is therefore a more consistent interpretation of tetrad data, than the derived 'percent cover' above.

MAVIS produces an output for each 'plot' or tetrad, giving vegetation class according to the Countryside Vegetation System (CVS) (Bunce *et al.*, 1999b), an aggregate value for Ellenberg's indicators (Ellenberg, 1979; Hill *et al.*, 1999) and aggregate values for Grime's Competition-Stress-Ruderality (CSR) plant strategy model (Grime *et al.*, 2007). When used with frequency values MAVIS also produces a list of closest fitting National Vegetation Communities (Rodwell, 1991 - 2000).

CSR ratios produced in this way are often expressed to two decimal places, which can be difficult to read, for example 1: 2: 1.4. These were rounded to the nearest 0.5, then multiplied by 2 to get whole figures, so 1:2: 1.4 becomes 2:4:3.

All of the results for MAVIS are highly speculative, because the TWINSPAN end groups do not represent systematic vegetation samples. Data from tetrads is also on a very large scale, which could be expected to reduce distinction between results for each group. To some extent, the latter problem has been reduced by only using the preferential species. The results do at least give a guide to whether or not the group has a high proportion of species with a preference for acidic conditions, or a low proportion of ruderal species, for example. Similar calculations have been used by Fanelli *et al.,* (2006) for whole site species lists in Rome, by Chocholoušková and Pyšek (2003)for differently sized zones in and around the city of Plzeň, and by McCollin *et al.,* (2000b) for 5 km x 5 km recording units in Northamptonshire.

5 TWINSPAN ANALYSIS

5.1 Background

5.1.1 Data structure

The study examined 813 2×2 km squares (tetrads) in the County of Staffordshire and the Black Country conurbation, where the area covered was greater than 25% of the tetrad. These represent 3,053 of the 3,081 square kilometre area (about 99%), defined by the Staffordshire Flora Group for recording for the Staffordshire Flora Project (Figure 3.1, Page 36). The Black Country is also covered by botanical recording in preparation for a Flora of Birmingham and the Black Country (Trueman *et al.*, in prep).

Species data were edited as outlined in Section 4.1 (Page 41), and as detailed in Appendix A, leaving a dataset of 1840 species.

TWINSPAN results and the following discussion are summarised in Table 5.16 at the end of Section 5.5 (Page 120). Selected results are presented in the text where the information is considered to be of particular help in interpretation; details are presented in Appendix C.

Figure 5.1 - Dendrogram showing first three levels of TWINSPAN analysis

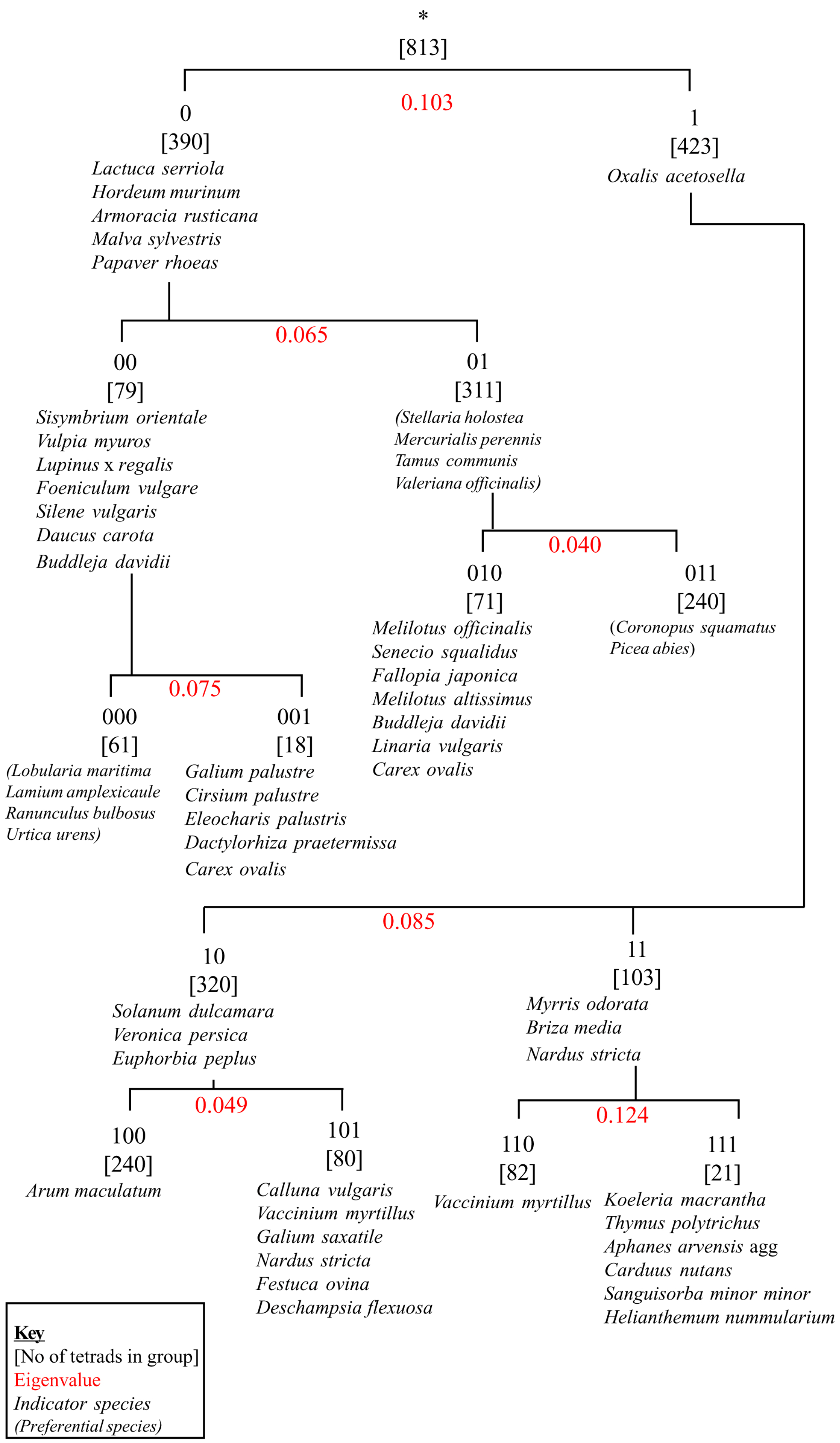
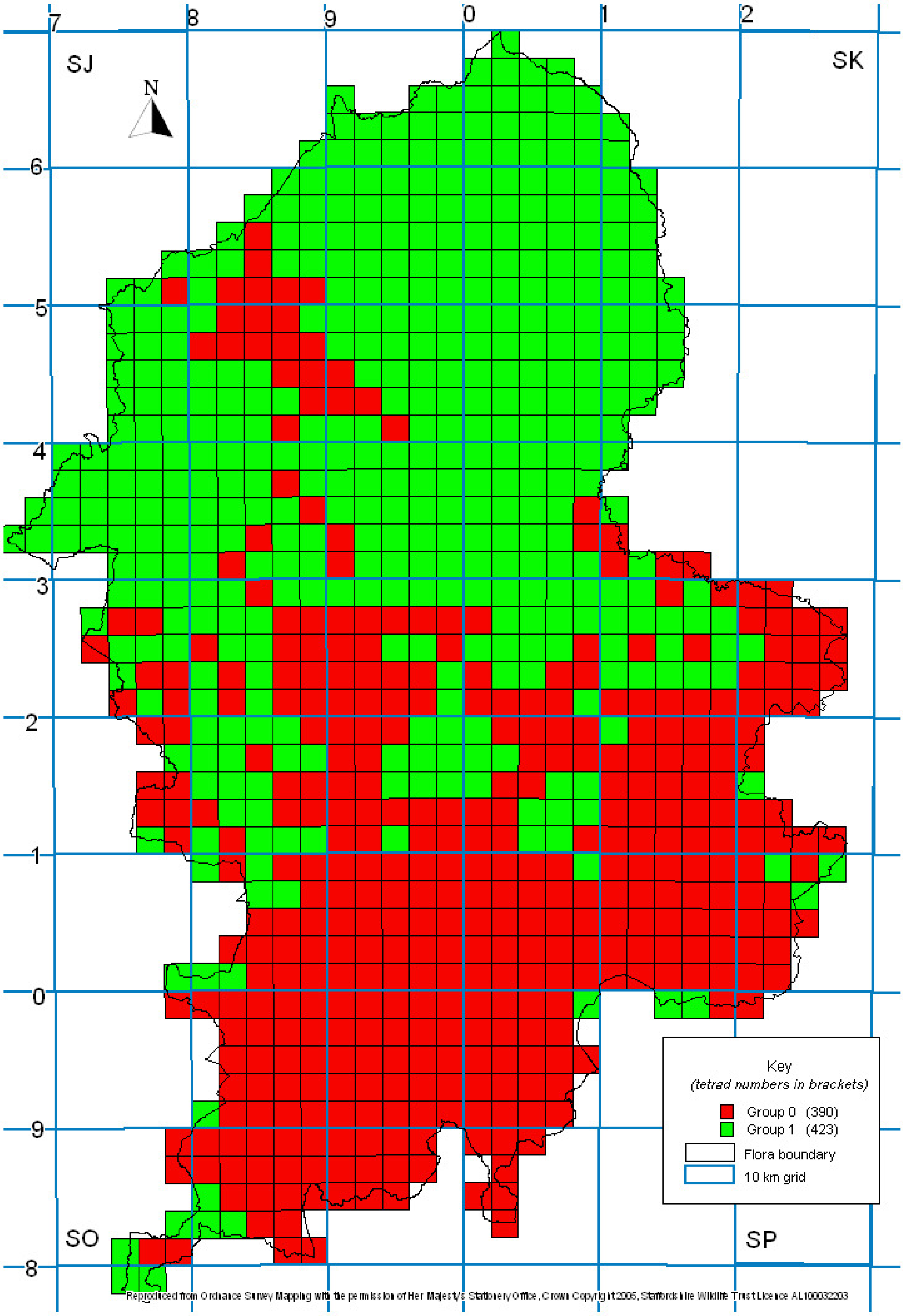


Figure 5.2 - Map showing TWINSPAN Level 1 groups



5.2 TWINSPAN level one

5.2.1 Groups 0 and 1

The TWINSPAN dendrogram for the first three levels is shown in Figure 5.1. The dataset of species information used was from 813 tetrads. This was separated at the first level into Group 0 (390 tetrads) and Group 1 (423 tetrads) with an eigenvalue of 0.103. All eigenvalues are low, however this might be expected for data where a considerable number of species are present across all tetrads.

The first division of the data appears to be largely concerned with the differences between urban or arable on one side and less agriculturally intense rural areas on the other. Group 0 (Figure 5.1) indicator species are mainly ones of areas with more human activity, such as *Lactuca serriola* and *Malva sylvestris*. There is only one indicator for group 1, *Oxalis acetosella*. The strongest preferentials for Group 1 include *Athyrium filix-femina, Potentilla sterilis* and *Stellaria alsine*, species of a variety of low-nutrient situations and / or unimproved habitats.

The non-preferentials for this level include many species of woodland and shade, showing that both Group 0 and Group 1 are likely to contain woodland habitat. However, the proportion of tetrads with characteristic woodland and shade species such as *Circaea lutetiana* and *Moehringia trinervia* in Group 0 is considerably lower (Table 5.1). Shade species which fairly readily invade relatively newly created and secondary habitats, such as *Arum maculatum, Alliaria petiolata* and *Glechoma hederacea* are present in similar proportions of Group 0 and Group 1 tetrads. *Carex pendula* and *Viola odorata* are more frequent in Group 0, however these species are also commonly grown in gardens, as are many of the larger fern species.

Table 5.1 - Occurrence of woodland and shade species* for Groups 0 and 1

Species	Group 0	Group 1	Species	Group 0	Group 1
	% of tetrads			% of tetrads	
Adoxa moschatellina	24	46	*Hedera helix*	98	94
Ajuga reptans	30	65	*Hyacinthoides non-scripta*	84	93
Alliaria petiolata	98	94	*Lamiastrum montanum*	13	35
Allium ursinum	32	43	*Lonicera periclymenum*	86	91
Anemone nemorosa	27	57	*Luzula sylvatica*	01	28
Arum maculatum	64	61	*Lysimachia nemorum*	13	50
Athyrium filix-femina	35	77	*Lysimachia nummularia*	31	27
Blechnum spicant	04	37	*Melica uniflora*	14	22
Bromopsis ramosa	42	47	*Mercurialis perennis*	63	82
Cardamine flexuosa	86	95	*Milium effusum*	21	29
Carex pendula	29	24	*Moehringia trinervia*	37	55
Carex remota	37	48	*Mycelis muralis*	17	23
Carex sylvatica	14	31	*Oxalis acetosella*	21	77
Ceratocapnos claviculata	09	30	*Phyllitis scolopendrium*	41	38
Chrysosplenum oppositifolium	18	61	*Poa nemoralis*	22	24
Circaea lutetiana	42	61	*Polypodium vulgare*	13	27
Dryopteris affinis	11	30	*Potentilla sterilis*	26	58
Dryopteris dilatata	83	96	*Primula vulgaris*	33	48
Dryopteris filix-mas	98	98	*Rumex sanguineus*	65	74
Equisetum sylvaticum	09	33	*Scrophularia nodosa*	66	75
Festuca gigantea	36	64	*Silene dioica*	91	96
Galium odoratum	13	25	*Stellaria holostea*	68	92
Geranium robertianum	97	99	*Veronica montana*	25	53
Geum urbanum	88	86	*Viola odorata*	23	15

KEY
Non-preferential
Group 1 preferentials

**native, non-woody species with an Ellenberg value of 5 or less for light (Hill et al., 1999).*

5.2.1.1 Group 0

Group 0 shows a strong human influence, with the indicator species all associated with human activity (Table 5.2), including *Armoracia rusticana, Hordeum murinum, Lactuca serriola* and *Malva sylvestris*. The indicators include the arable weed *Papaver rhoeas*, which does also occur in disturbed urban areas. All of the indicator species for Group 0 are listed as archaeophytes (Preston *et al*., 2002), as are many of the preferentials, such as *Raphanus raphanistrum, Silene latifolia, Papaver dubium* and *Papaver somniferum*. By contrast, Group 1 preferentials (Table 5.3) are predominantly native, with only *Claytonia sibirica* and *Larix* x *marschlinsii* (both neophytes) as exceptions among 54 taxa.

Group 0 has a high proportion of annuals (47%), and a somewhat lower proportion of neophytes (12%); these were considered by Hill *et al.,* (2002) as potential indicators of urbanity. By comparison, 5.5% of preferential species in Group 1 are annuals, and only 4% are neophytes.

Group 0 tetrads are mainly distributed south of a line drawn midway across the County between SJ700300 and SK280300, in the more densely-populated parts of the County (Figure 5.2). The areas covered include all of the Black Country, Cannock, Tamworth and Lichfield. They also cover the towns of Stafford, Stone, Burton-upon-Trent and Uttoxeter, and most of the Stoke-on-Trent conurbation. Leek and Cheadle to the north east of the County are entirely within Group 1, even though their size and status as market towns are comparable with Stone and Uttoxeter within Group 0. None of the Leek or Cheadle tetrads are listed within the borderline or misclassified tetrads for Group 1. One edge of Stone (SJ83W) is listed as borderline and one edge of Uttoxeter (SK03S) is listed as misclassified for Group 0; these parts of the towns are mainly residential with farmed land, and are probably less urban in character. Leek and Cheadle must therefore be distinct from other towns in the County in their botanical characteristics.

Figure 5.5 shows the location of Group 0 tetrads in relation to built development, and there does appear to be a strong degree of correlation, particularly in the centre and the south of the County. These areas also tend to have a greater proportion of roads, railways and other infrastructure, which do not appear in Figure 5.3. In addition, derelict or abandoned features may also have contributed to shape some of these tetrads in the past, such as disused railways. The CSR value for the preferentials calculated using MAVIS was 5:4:7, indicating that the group is strongly ruderal, with relatively low stress tolerance (Grime *et al.*, 2007), compared to Group 1 (4:7:4), which appears to be a stress-tolerant group, with low ruderality.

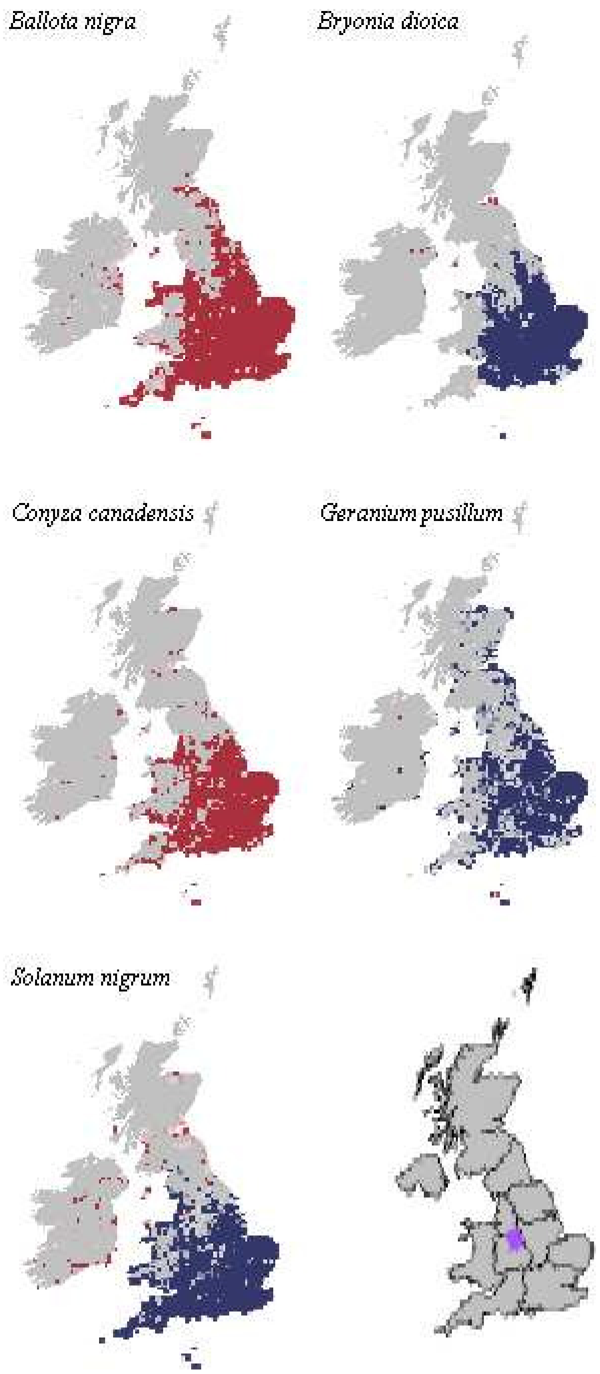
One of the indicators for Group 0 (*Papaver rhoeas*), and over one-fifth of the preferentials are characteristic of rural arable land as well as urban disturbed land, including *Anagallis arvensis, Solanum nigrum, Urtica urens, Silene latifolia* and *Raphanus raphanistrum.* All of these species occur in more than half of Group 0 tetrads. While arable conditions may occur in gardens and allotments in urban areas, it seems likely that group 0 tetrads will also be found in predominantly arable land in the more rural areas. Values calculated for the preferentials using MAVIS (Table 5.4) gave an Ellenberg nitrogen score of 6.1, which indicates that these species are found in sites of intermediate to rich fertility (Ellenberg, 1979; Hill *et al.*, 1999), in contrast with Group 1 (nitrogen score of 3.9), which appears to have areas of much lower fertility.

Group 0 indicators and preferentials are mainly species with a predominantly lowland and southern or eastern geographical distribution (Figure 5.3). The proportion of species that barely reach Scotland is around a third of those listed in Table 5.2, while the remainder tend to be confined to central and eastern Scotland. Nearly all species are also absent from, or restricted in, upland areas of Wales and Cumbria, confirming that the Group is characteristically lowland. Figure 5.4 shows the biogeographic attributes of species in Groups 0 and 1. Group 0 has predominantly species of Eurosiberian southern-temperate elements (warmer, southern locations), while a large proportion of Group 1 species are of the European temperate element (cooler climates) (Hill *et al.*, 2004).

A number of the weaker preferentials for Group 0 (Appendix C) are species of open water or water margins; these include *Rumex hydrolapathum, Carex otrubae, Impatiens capensis, Scutellaria galericulata, Salix alba* and *Oenanthe crocata.* Canals tend to be concentrated in towns, and this may well account for these open water preferentials, which are mainly species typical of canal margins. Open water species are present in only around a third of tetrads, and are probably not the main defining factor at this level, although these species are present at much lower frequencies in Group 1 tetrads.

Group 0 may therefore be defined as the group of tetrads with a strong anthropocentric tendency and a high prevalence of archaeophyte species, and which is associated with development or arable farming.

Figure 5.3 - Group 0 preferentials with a southern and/ or eastern distribution*



*Figures taken from 'New Atlas of the British and Irish Flora (Preston *et al.*, 2002) except inset (UK regions and Staffordshire location)

Table 5.2 - Preferential species in Group 0 tetrads (over 50% occurrence)

Species	**% of tetrads**	**Species**	**% of tetrads**	**Species**	**% of tetrads**
Aethusa cynapium^	75	Fumaria officinalis*^	66	Persicaria lapathifolia^	52
Anagallis arvensis^	74	Geranium pusillum^	56	Raphanus raphanistrum*^	63
Armoracia rusticana*	90	Hordeum murinum*^	85	Reseda luteola*	73
Artemisia absinthum*	62	Hypericum perforatum	81	Sagina apetala^	54
Ballota nigra*	62	Lactuca serriola*^	87	Salix alba*	53
Bryonia dioica	55	Linaria vulgaris	55	Senecio squalidus+	64
Buddleja davidii+	55	Malva moschata	50	Silene latifolia*	81
Cochlearia danica^	58	Malva sylvestris*	89	Solanum nigrum^	54
Conium maculatum*	51	Papaver dubium*^	76	Tanacetum vulgare	58
Convolvulus arvensis	76	Papaver rhoeas*^	84	Urtica urens*^	52
Conyza canadensis+^	67	Papaver somniferum*^	65		
Dipsacus fullonum	68	Pentaglottis sempervirens+	71		

KEY		
Garden species	Waste ground / roads railways etc	Cultivated / disturbed land
Grassland	Water / wetland	Indicator species
* archaeopyte	+ neophyte	^annual

Table 5.3 - Preferential species in Group 1 tetrads (above 50% occurrence)

Species	**% of tetrads**	**Species**	**% of tetr ads**	**Species**	**% of tetrads**
Ajuga reptans	65	Glyceria notata	51	Ranunculus flammula	56
Anemone nemorosa	57	Lychnis flos-cuculi	52	Stellaria uliginosa	79
Athyrium filix-femina	77	Lysimachia nemorum	50	Succisa pratensis	56
Campanula rotundifolia	58	Oxalis acetosella	77	Valeriana officinalis	72
Chrysosplenum oppositifolium	61	Potentilla erecta	76	Veronica montana	53
Galium saxatile	63	Potentilla sterilis	58		

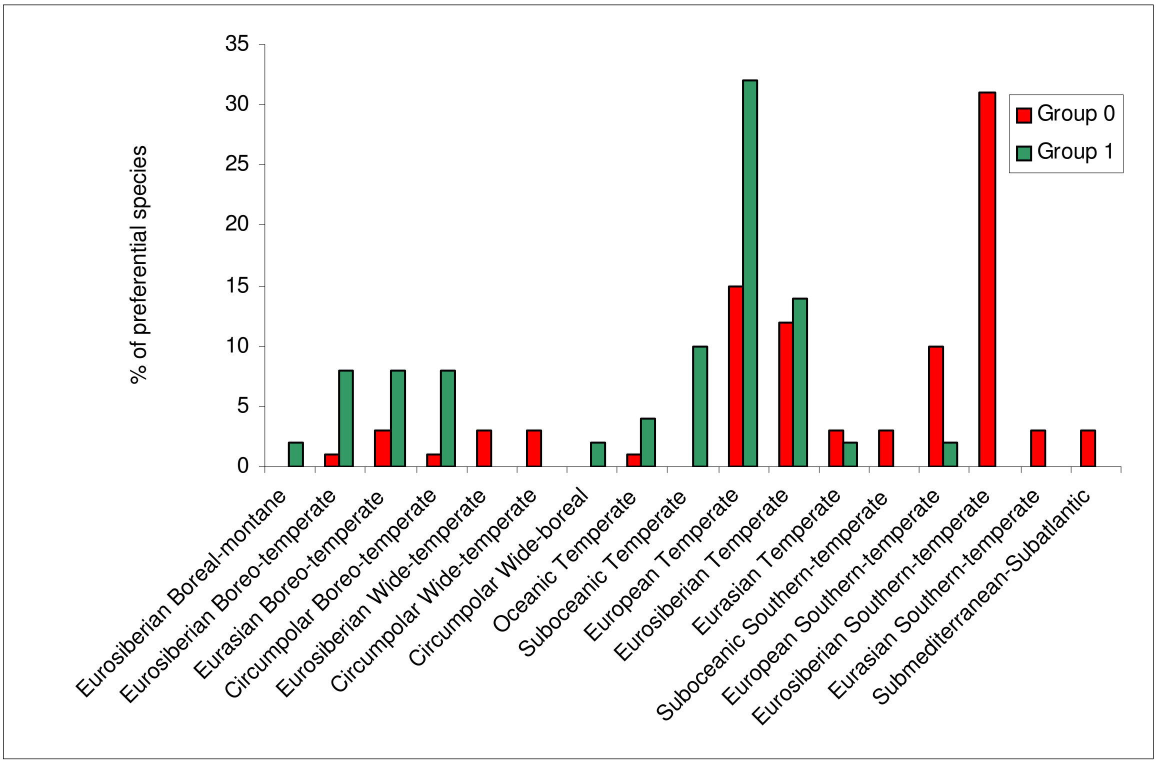
KEY	
Woodland	Heathland / acidic
Grassland	Wetland

Table 5.4 - CSR strategy and Ellenberg values for Groups 0 and 1*

	Group 0	Group 1
Grime Strategy C/S/R	5/4/7	4/7/4
Light	7.3	6.1
Wetness	5.0	6.6
pH	6.9	4.9
Fertility	6.1	3.9

** values calculated using MAVIS, as described in section 4.3.5.*

Figure 5.4 - Geographic attributes of preferential species for Groups 1 and 0*



**calculated using MAVIS software*

5.2.1.2 Group 1

Group 1 tetrads are distributed mainly to the centre and north of the County (Figure 5.2), and in the south are for the most part situated around Kinver, the Wyre Forest and Cannock Chase. Group 1 tetrads are generally absent from urban areas, and these include the least developed, rural parts of central and southern Staffordshire (Figure 5.5). In the north of the County, Group 1 also incorporates the towns of Leek, Cheadle, Biddulph and part of Newcastle. Therefore, other factors as well as a lack of development may define the Group.

The only indicator for group 1 is *Oxalis acetosella* (Figure 5.1), which is predominantly a species of old woodland and hedges. Table 5.1 shows that many woodland species are found in large proportions of Group 1 tetrads including *Lysimachia nemorum, Mercurialis perennis* and *Moehringia trinervia.* The strongest preferentials include *Athyrium filix-femina, Chrysosplenum oppositifolium, Potentilla sterilis, Campanula rotundifolia, Valeriana officinalis* and *Stellaria alsine*, which would imply that a combination of woodlands, grasslands and wetlands are present in the tetrads in this group. The remaining preferentials are mainly species of these habitats and heathland or acidic grassland (*Vaccinium myrtillus, Potentilla erecta, Nardus stricta* and *Juncus squarrosus*). Most of the preferentials appear to be species of low-nutrient situations and / or unimproved habitats. Therefore, it appears that Group 1 contains tetrads with a range of semi-natural vegetation.

All of the preferentials are native species, except for *Larix* x *marschlinsii, Myrrhis odorata* and *Claytonia sibirica*, suggesting a limited effect of human activity and probably a predominance of semi-natural habitats, compared to Group 0 with its predominantly archaeophyte and neophyte species.

Oxalis acetosella, and several of the preferentials including *Anemone nemorosa, Campanula rotundifolia, Galium saxatile, Potentilla erecta, Potentilla sterilis, Succisa pratensis, Valeriana officinalis* and *Veronica montana* are noted as being absent from arable areas by Grime (2007), which contrasts with Group 0 where a high proportion of the species are associated with arable areas.

Of the 17 species listed in Table 5.3, only 12 are listed in 'The Plants of Nottingham – A City Flora' (Shepherd, 1998). Of these, only one, *Potentilla sterilis*, is described as having a wide distribution on allotments, railway cuttings, embankments and scrub; this is now acknowledged to be a typographical error for *Fragaria* x *ananassa* (P Shepherd pers. comm.), while *Potentilla sterilis* should be regarded as a localised species in the City. The remainder have 'rare' or 'localised' distributions, with *Ranunculus flammula, Ajuga reptans* and *Athyrium filix-femina* recorded from only one site each. This supports the view that these species are not at all prevalent in urban areas, again contrasting with Group 0 where a high proportion of species were described as 'common', 'widespread' or 'frequent' in Nottingham (62% of species in Table 5.2).

Most of the preferentials for the group are species of low-nutrient situations. The value calculated for the preferentials using MAVIS, gave a nitrogen score of 3.9, which indicates low to intermediate fertility (Ellenberg, 1979; Hill *et al.*, 1999), which was considerably lower than the value for Group 0 (6.1). The calculated value for CSR strategy (Grime *et al.*, 2007) was C4:S7:R4 indicating a stress-tolerant group of species, which contrasts with the values for Group 0, which is a ruderal, stress-intolerant group. Stress tolerance may be associated with less productive and less improved habitats. For example, in their analysis of change in the British Countryside (Bunce *et al.*, 1999b) stress tolerance was calculated to be part of all main strategies for both moorland grass / mosaic vegetation and for heath / bog vegetation. In infertile grassland vegetation, the presence of a number of stress-tolerant species was considered to suggest lower productivity than for other grassland vegetation. Therefore, the predominance of stress tolerant species in Group 1 supports the view that the tetrads contain less-improved habitats.

Care needs to be taken in extrapolating one-record-per-tetrad data to infer the presence of habitats because species may clearly be found in atypical situations away from their preferred semi-natural habitat, or persisting as relicts of former habitat. However, this is less likely for species that are very restricted in their requirements, particularly by low nutrient requirements. It is therefore reasonable to infer that semi-natural habitats are more likely to be found in Group 1 tetrads.

A further influence on the distribution of the Group might be geographical location. Edees (1972) considered that Staffordshire's location was partly responsible for the diversity of the flora, with species of southern, northern, western and eastern UK distributions. Preferentials for Group 1 with northern distributions include *Myrrhis odorata* and *Salix pentandra* (native populations). Others, while not solely northern, are scarce in central England, including *Blechnum spicant, Vaccinium myrtillus* and *Geum rivale* (Figure 5.6). Figure 5.4 shows the biogeographical affinities of species in both Groups, as mentioned above.

Group 1 can therefore be characterised as the least developed parts of the County, which are rich in semi-natural habitat, including woodlands, grasslands, heathlands and wetlands, or 'semi-natural habitat rich rural Staffordshire' in short.

5.2.1.3 Level 1 summary

In summary, the botanical characteristics of the County appear to divide into agriculturally intensive or industrially developed southern areas and more rural and less intensively managed northern areas. Woodland is apparently widely distributed, although the more rural areas have a stronger presence of typical ancient woodland species.

Although core areas of the Stoke conurbation share botanical characteristics with the Black Country, the peripheral areas have more in common with the rural areas. In several northern towns, including Leek, these rural characteristics do not give way to those of development, but define even the town centres in botanical terms.

Geography appears to be a factor in the botanical data, dividing the County into areas that have affinity with the lowland south and east of the UK (Eurosiberean southern-temperate element), and areas with a stronger affinity with the predominantly upland north and west (European temperate element).

Figure 5.5 - Groups 0 and 1, showing built development

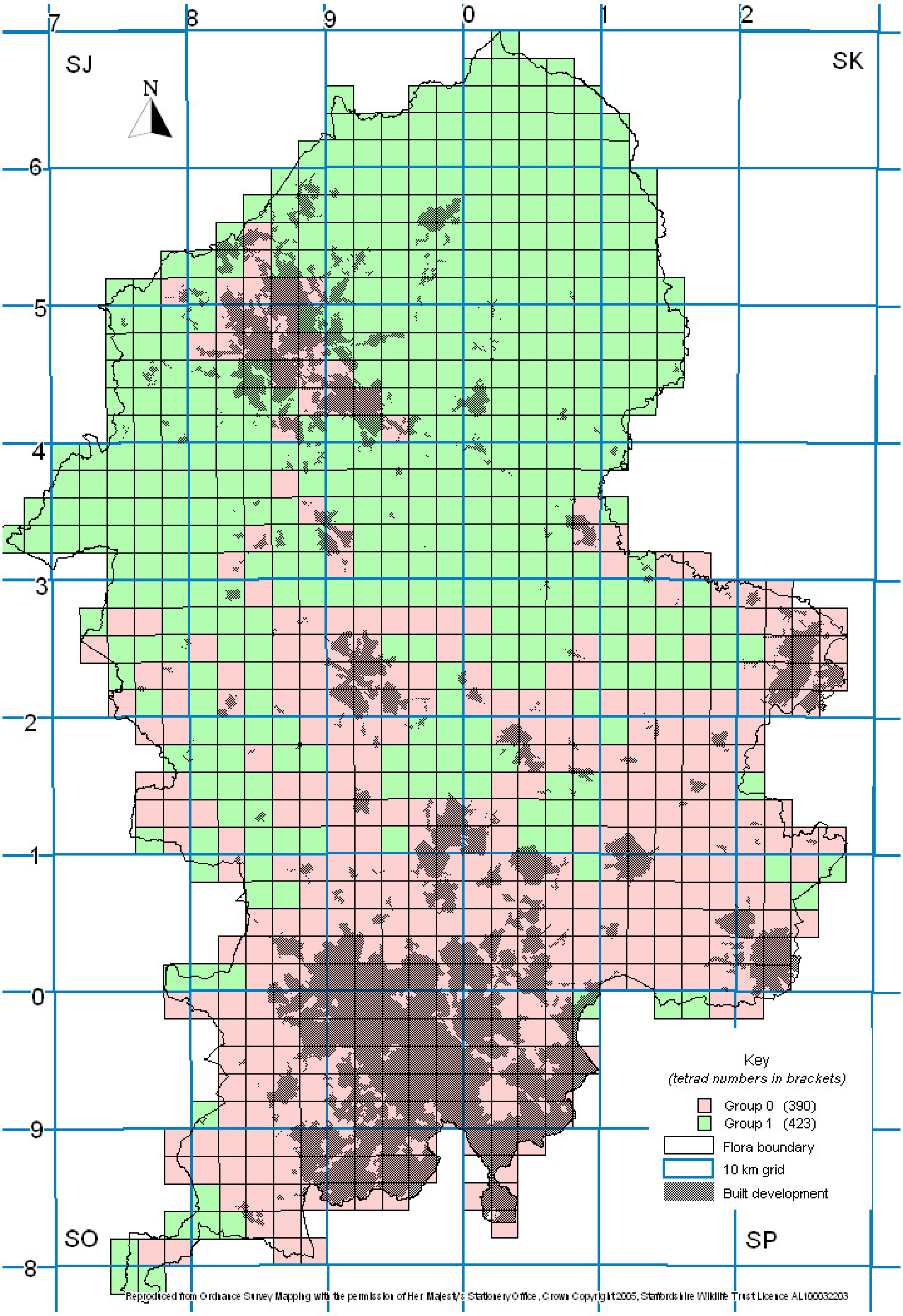
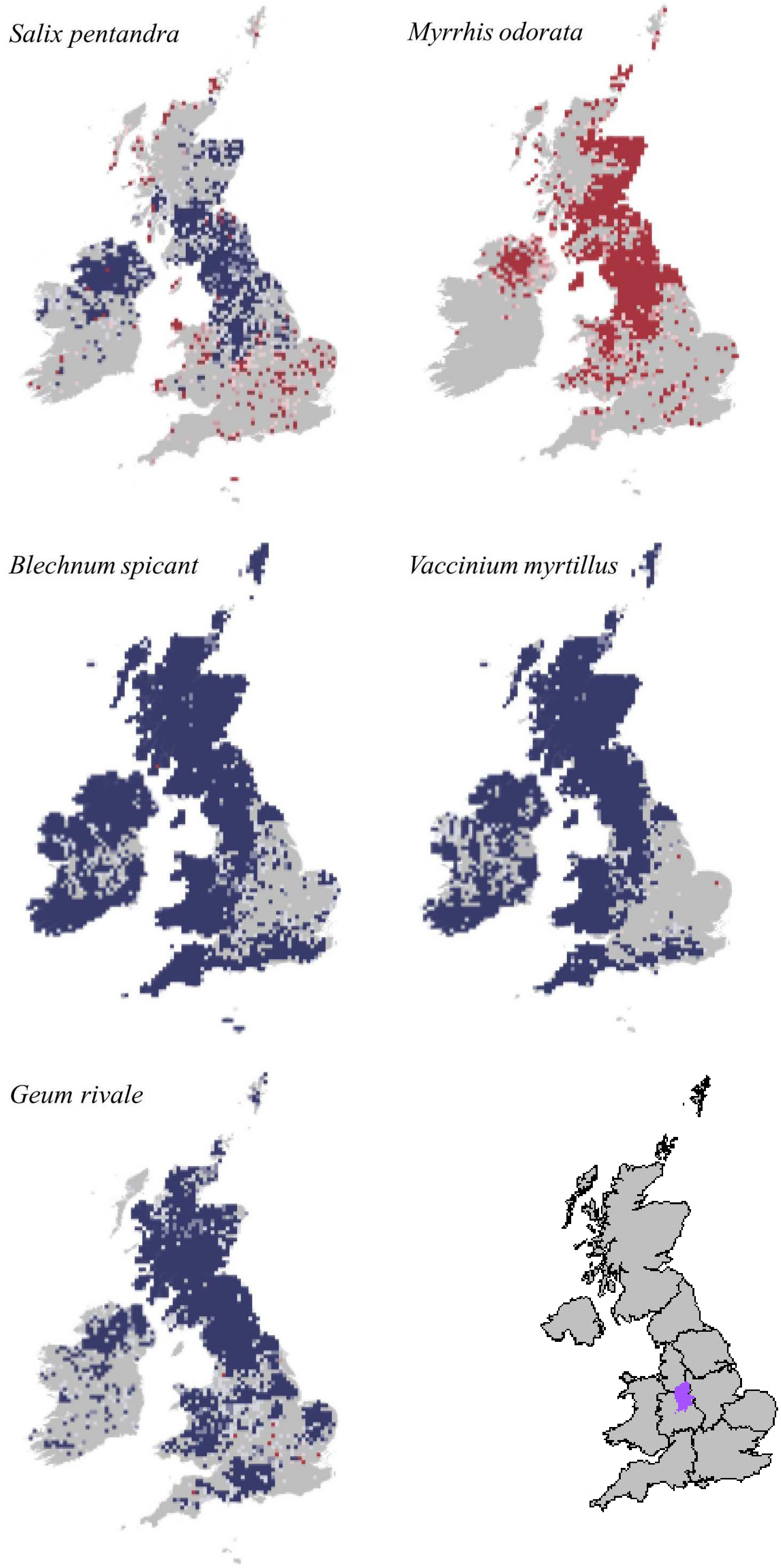


Figure 5.6 - Group 1 preferentials with a northern and/ or western distribution*



Figures taken from 'New Atlas of the British and Irish Flora (Preston *et al.*, 2002) except inset (UK regions and Staffordshire location)

5.3 TWINSPAN level two

5.3.1 Groups 00 and 01

The group associated with development or arable farming, Group 0, divides into group 00, with 79 tetrads and group 01 (311 tetrads), with an eigenvalue of 0.065.

5.3.1.1 Group 00

Group 00, which is located mainly in the Black Country and in Stoke-on-Trent (Figure 5.5), has indicators that include *Vulpia myuros, Foeniculum vulgare, Buddleja davidii* and *Lupinus* x *regalis* (dendrogram - Figure 5.1), which are all species with a high degree of urbanity. *Sisymbrium orientale* is also an indicator that is 'strongly associated with species having high urbanity' (Hill *et al.*, 2002).

Group 00 therefore has mainly indicators that are particularly associated with the built environment. It also has *Daucus carota*, which is a species of open, usually nutrient poor habitats, often with a degree of disturbance, such as railway embankments. *Silene vulgaris* is also an indicator for Group 00; it occurs in similar situations, but also in arable areas where the nutrient status may be higher.

Of all the species of high urbanity listed by Hill *et al.,* 17 are found in the preferentials for Group 00, none in the preferentials for Group 01, and ten in the non-preferentials, showing that the urban influence is much stronger in Group 00 than in Group 01. In Table 5.5, eight species are annuals (22%) and 21 are neophytes (58%). Proportions of annual and neophyte species were together considered helpful in indicating urbanity by Hill *et al.,* and this appears to support the view that Group 00 is the most urban of the groups at this level.

Of the remaining 127 preferentials not listed by Hill *et al.*, many are also characteristic urban or garden species (Table 5.2). Species of garden origin feature strongly in the preferentials, including *Syringa vulgaris, Meconopsis cambrica*, *Antirrhinum majus* and *Ligustrum ovalifolium*. Although species of garden origin are now frequent in other habitats, these invariably show a strong human influence and are rarely found in locations remote from human habitation. Species of garden origin are relatively weakly represented in Group 01 by comparison to Group 00.

Numerous species in Table 5.2 are listed as typical components of derelict land, railways or other urban land in Nottingham (Shepherd, 1998), including *Reseda lutea* and *Linaria vulgaris*. Many others were common or widespread in that city, including *Lamium amplexicaule* and *Solidago canadensis*.

Some preferentials are open water and marginal species, such as *Eupatorium cannabinum*, *Elodea nuttalli, Oenanthe crocata*, *Potamogeton pectinatus* and *Bidens frondosa*; these are weak preferentials and are also found in a proportion of Group 01 tetrads. Both the Black Country and Stoke-on-Trent have many kilometres of canals in which these species are characteristic. There are also disused canal sections where open water species requiring better water quality or less disturbance from boat traffic are found. These are also among the preferential species for the group, such as *Butomus umbellatus* and *Alisma lanceolatum*.

Wetland species also feature prominently in the non-preferentials, and are mainly species that may be components of wetlands, or of marginal situations around ponds and canals, such as *Filipendula ulmaria, Cardamine pratensis, Juncus articulatus, Lotus pedunculatus Caltha palustris* and *Alopecurus geniculatus*. It is therefore possible that these species occupy different positions in Group 00 than in Group 01, with more canal situations in the former, and more wetland situations in the latter.

A small group of preferentials are species of grasslands, including *Knautia arvensis*, *Odontites vernus* and *Rhinanthus minor*. These are species of unimproved grassland, which sometimes persists better in old industrial areas than in the countryside. These may also be found in post-industrial habitats, usually once some degree of grassland cover has established. Additionally grassland species such as *Cerastium fontanum, Rumex acetosella, Plantago lanceolata, Crepis capillaris* and *Anthoxanthum odoratum* are almost constant throughout the group and are listed in the non-preferentials.

Therefore, remnants at least of grassland and wetland habitat survive in Group 00 and Group 01. Their presence in Group 00 appears to support the views of Teagle who recognised that the post-industrial areas of the Black Country had developed considerable wildlife value (Teagle, 1978). The same may be said to be true for Stoke-on-Trent.

Just under 10% of the preferentials are non-native tree and shrub species such as *Alnus incarna, Cornus alba, Sorbus intermedia* and *Cornus sericea*, most of which are frequently planted in urban situations in ornamental schemes. Another non-native preferential, *Platanus* x *hispanica*, is a very common pollution-tolerant street tree. These species are present in only 7 – 22% of Group 01 tetrads, indicating that ornamental planting and street trees are likely to be largely confined to Group 00 tetrads.

Compared to Group 01, which has a high proportion of woodland species, none of the preferentials are species of woodland, or even shade. The only non-preferentials with a preference for these habitats occurring in more than 50% of Group 00 tetrads are *Alliaria petiolata, Geum urbanum, Hedera helix, Myosotis sylvatica* and *Hyacinthoides non-scripta*, most of which can also be found in other situations. *Myosotis sylvatica*, for example, is also a frequent garden escape.

Geographic attributes for the two groups occupy similar broad ranges from Oceanic Boreo-temperate through to Submediterranean-Subatlantic (Hill *et al.*, 2004) and are therefore not shown graphically.

The tetrads in Group 00 are confined to the urban areas of the Black Country, the Brownhills to Cannock area, Stafford, Lichfield and Stoke. Except in the Black Country and Stoke, the tetrads in this group have a widely scattered distribution, indicating that they are confined to core urban areas. This could therefore be said to be the archetypical 'urban centre' group. Group 00 can therefore be regarded as the defining core urban Group for the County.

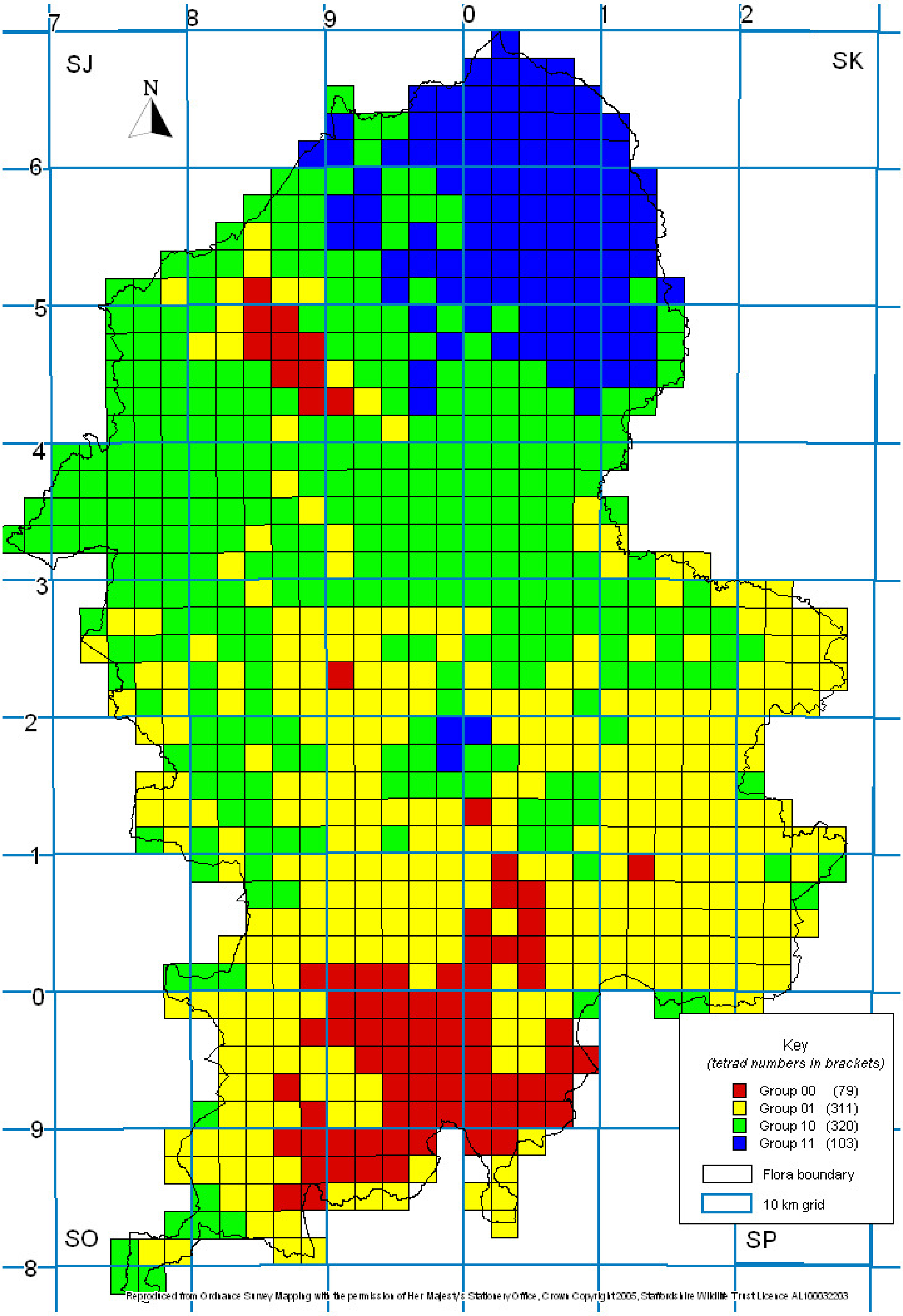
Group 00 represents only around 10% of the County by area, indicating that the effects of its industrial legacy are confined to relatively small areas. Overall, the County is predominantly agricultural, with agricultural indicators predominating in the other groups at this level.

Table 5.5 - Preferential species in Group 00 tetrads (over 50% occurrence)

Species	% of tetrads	Species	% of tetrads	Species	% of tetrads
Alnus incarna+	65	Linaria vulgaris	97	Sedum acre	71
Antirrhinum majus+^	52	Lobularia maritima+^	54	Sedum rupestre+	63
Aquilegia vulgaris	56	Lupinus x regalis+	73	Silene vulgaris	80
Buddleja davidii+	99	Odontites vernus^	62	Sisymbrium orientale+^	87
Cerastium tomentosum+	68	Oenanthe crocata	68	Solidago canadensis+	68
Daucus carota	84	Oenothera glazioviana+	76	Sorbus aria	63
Crocosmia x crocosmiiflora+	52	Populus alba+	65	Sorbus intermedia+	73
Foeniculum vulgare*	76	Populus x canescens+	51	Syringia vulgaris+	75
Laburnum anagyroides+	70	Potamogeton pectinatus	72	Trifolium arvense^	61
Lamium amplexicaule*^	63	Reseda lutea	71	Viola x wittrockiana+^	54
Ligustrum ovalifolium+	91	Rosa rugosa+	52	Vulpia bromoides+	58
Linaria purpurea+	90	Scutellaria galericulata	63	Vulpia myuros*^	92

KEY		
Garden species	Waste ground	Amenity planting
Grassland	Open water	Walls / rocks
*Archaeophyte	Neophyte+	Annual^

Figure 5.7 - Map showing second level of TWINSPAN analysis



5.3.1.2 Group 01

Group 01 lacks indicators, and so may be defined by this lack of species of high urbanity, and by its presence in the parent group 0, as a group of peripheral developed areas or of arable areas. Fifteen of its twenty-six preferentials are species of woods and / or hedges (Table 5.3), such as *Arum maculatum, Mercurialis perennis, Rumex sanguineus, Glechoma hederacea* and *Stellaria holostea;* these are very weakly represented in Group 00 by contrast. Seven of the 27 Group 01 preferentials are wetland species <u>not</u> associated with canals, such as *Valeriana officinalis* and *Stellaria uliginosa*; these are present in fewer than 20% of Group 00 tetrads, except for *Cirsium palustre* (30%) and *Persicaria hydropiper* (22%). These species all show a greater or lesser tendency to be confined to the margins of the Black Country (Trueman, pers. comm.), suggesting that they are unsuited to urban conditions.

Other preferentials include species from a range of non-intensively managed habitats such as *Cirsium palustre*, *Cardamine amara*, *Stachys palustris* and *Phleum bertolonii*. It is likely that the Group also has non-eutrophic wetlands as species such as as *Stellaria uliginosa* and *Cirsium palustre* tend to be confined to these habitats.

Two further preferentials are species of planted coniferous woodland; *Picea abies* and *Larix decidua*. These 'forestry' species emphasize the differences between the two groups; introduced tree species in Group 00 are species of ornamental planting schemes, while those in Group 01 are forestry species.

Tetrads in Group 01 are mainly found in the south of the County, with a few outlying tetrads around Stoke and Stone. These areas tend to have a low cover of ancient woodland sites, compared to Group 1 tetrads (Figure 5.6, Table 5.4), but a greater cover than Group 00 tetrads and obviously many fewer records of the species associated with the built environment listed in Table 5.5. Although the means are very different, the standard deviation demonstrates considerable overlap in woodland cover between the groups. It is likely that the woodland or shade tolerant species in Group 01 are confined to hedges and small copses (the Ancient Woodland Inventory does not list sites under 2 hectares) (Natural England, 1999b; Natural England, 1999a).

Non-preferentials include a number of species of grasslands, such as *Centaurea nigra, Galium verum, Leontodon autumnalis, Pilosella officinalis* and *Ranunculus bulbosus*, and it is likely that grasslands are present throughout lowland Staffordshire (in both groups 00 and 01), probably in remnant situations along verges, railway tracks and similar situations. Grassland may also develop in post-industrial situations over time.

Table 5.6 - Preferential species in Group 01 tetrads (all occurrences)

Species	**% of tetrads**	**Species**	**% of tetrads**	**Species**	**% of tetrads**
Adoxa moschatellina	30	Glechoma hederacea	85	Rumex sanguineus	73
Anemone nemorosa	31	Larix decidua	42	Stachys palustris	39
Arum macu1atum	72	Malva neglecta	24	Stellaria uliginosa	36
Cardamine amara	28	Mercurialis perennis	71	Stellaria holostea	79
Carex remota	43	Moehringia trinervia	42	Tamus communis	58
Carex riparia	23	Persicaria hydropiper	46	Valeriana officinalis	35
Chrysosplenum oppositifolium	21	Phleum bertolonii	33	Veronica montana	30
Cirsium palustre	62	Picea abies	23	Viola odorata	35
Elymus caninus	37	Primula vulgaris	36		

KEY		
Woodland	Waste ground	Open water
Shade	Wetland	Forestry
Grassland		

Table 5.7 - Ancient woodland cover in Level 2 Groups

Group	**Average Ancient Woodland cover (includes AW replanted**	**Standard deviation**
00	0.26 %	4.40
01	0.82%	8.98
10	3.1 %	26.77
11	2.7%	20.15

Table 5.8 - CSR strategy and Ellenberg values for Groups 00 and 01*

	Group 00	Group 01
Grime Strategy C/S/R	4/5/6	6/5/6
Light	7.2	5.5
Wetness	5.2	6.3
pH	6.8	6.4
Fertility	5.2	6.0

** values calculated using MAVIS as described in Section 4.3.5.*

Group 01 tetrads are split between lowland rural and suburban areas. The Group is somewhat undefined, probably lacking the 'urbanness' of Group 00 and the unimproved / undisturbed habitats of Group 1. Small hedges or copses and non-eutrophic wetlands are likely to be the main distinguishing factors from Group 00. The preferential species may reflect the persistence of small blocks of non-intensively-managed, possibly ancient habitats even in intensive agriculture and urban periphery areas, which are much scarcer in the urban area. Remnants of grassland vegetation however appear to be present throughout the lowland areas, as are ponds and canals.

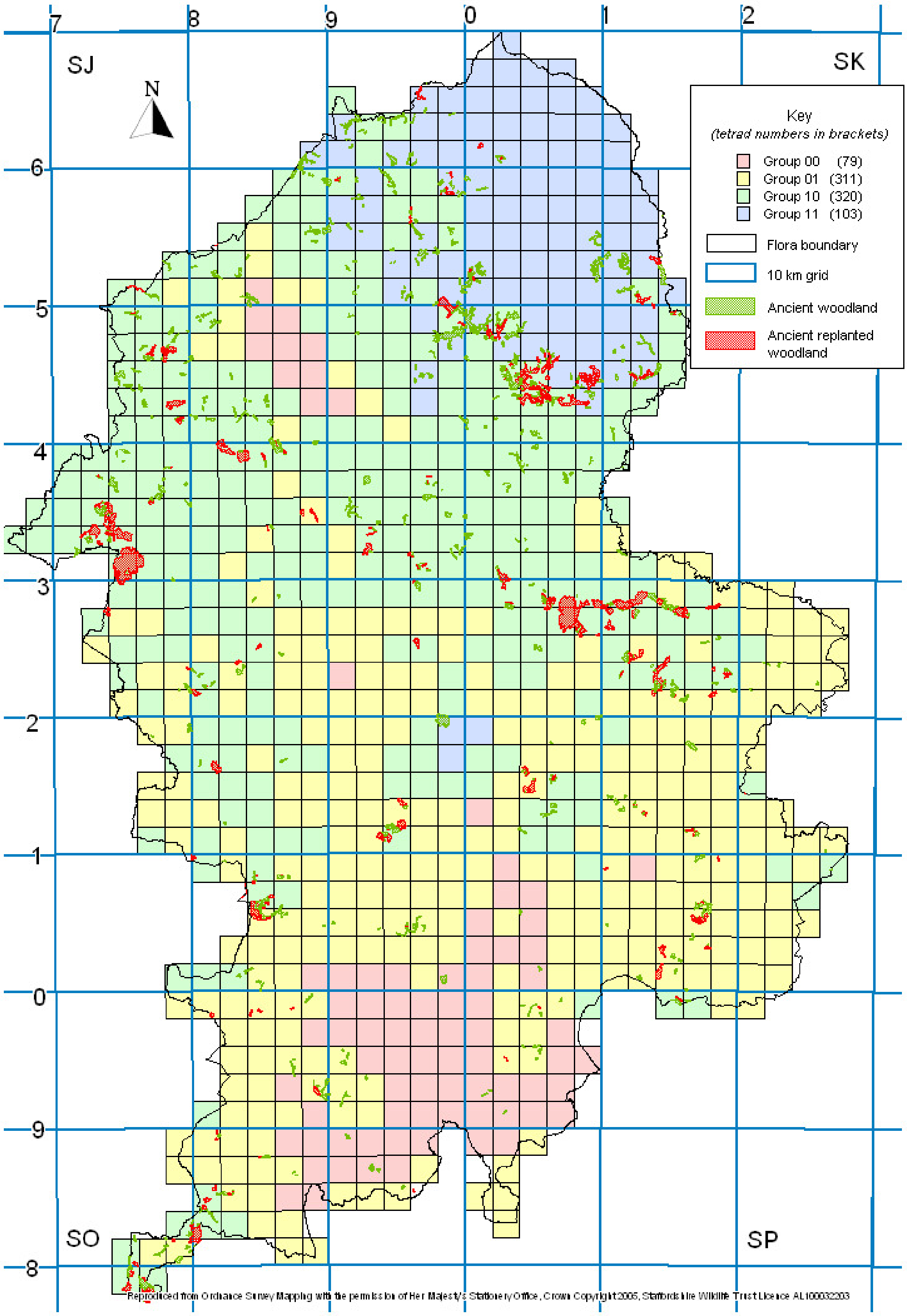
Group 01 may then be described as the predominantly agricultural, lowland parts of the County with a strong influence of human habitation, with surviving hedges, copses and non-eutrophic wetlands that are lacking in Group 00.

5.3.1.3 Groups 00 and 01 summary

Group 00, the core urban group, is characterised by species with a high degree of urbanity (Hill *et al.*, 2002), including many species associated with derelict land or similar habitats as described in Nottingham (Shepherd, 1998). These species are barely represented in Group 01, which is characterised mainly by species of non-intensively managed habitats and may be defined as the urban-fringe or arable group typical of lowland Staffordshire.

Both groups have species of canals, although these are more frequent in Group 00, indicating the importance of this habitat in lowland Staffordshire. Both Groups also have species of grassland, demonstrating that grassland remains a relatively widespread habitat in the County. A contrast between the Groups is shown by planted tree species, which in Group 00 are typical of ornamental and street planting schemes, while in Group 01 they are species of forestry.

Figure 5.8 - Map showing TWINSPAN second level with Ancient Woodland



5.3.2   Groups 10 and 11

Group 1, comprising 'semi-natural habitat rich rural Staffordshire' with an apparent range of semi-natural vegetation in its tetrads, divides at Level 2 into group 10, with 320 tetrads and group 11, with 103 tetrads, with an eigenvalue of 0.085.

5.3.2.1 Group 10

The indicators for this group include *Veronica persica* and *Euphorbia peplus*, species of somewhat disturbed conditions, usually in arable or other cultivated situations. The remaining indicator, *Solanum dulcamara* is a species of predominantly damp conditions in usually shaded situations, typically on nutrient-rich substrates. The strongest preferentials include arable weeds (Table 5.5) such as *Urtica urens, Matricaria recutita, Euphorbia helioscopia, Anagallis arvensis* and *Viola arvensis*. *Geranium dissectum* is also strongly preferential, occurring in 249 of the tetrads; this is a species of disturbed situations such as verges and field edges in lowland areas, being also associated with human activity. A high proportion of species (56% in Table 5.5) are annuals, which is consistent with arable conditions.

The preferentials also show an apparent human influence in such archaeophyte species as *Sisymbrium officinale* and *Papaver somniferum,* although these are relatively weak preferentials, occurring in one third of the tetrads. The suggestion is that these species are particularly scarce in Group 11 tetrads by comparison.

A small group of strong preferentials for Group 10 are species of water or water edges, often preferring nutrient-rich conditions. These include *Alisma plantago-aquatica, Apium nodiflorum, Solanum dulcamara* and *Ranunculus sceleratus*. These are very scarce in Group 11, although there are species of open water in the non-preferentials. These tend to be those of less nutrient-rich situations including *Veronica beccabunga* and *Equisetum fluviatile*, possibly indicating that any open water in Group 11 tetrads is less eutrophicated, while Group 00 tetrads contain both eutrophic and less eutrophic water.

A small, relatively weak group of preferentials includes species of shade, woodlands or hedges, such as *Moehringia trinervia* and the archaeophyte *Chelidonium majus*, although many woodland species are non-preferential.

Group 10 tetrads are found in the northern and central lowlands of Staffordshire, in the periphery of the major urban areas of Stafford and the Black Country, but within Stoke and Leek. This Group is the largest at this level and clearly transitional with Group 01, including both shade species and species of urban and disturbed areas, however Group 01 does not have arable species within its preferentials.

Apart from *Moehringia trinervia*, Group 10 lacks woodland species as preferentials. The main differences between the two Groups therefore appear to be that arable farming has a stronger influence on Group 10 **at this level**, while woodlands are a stronger influence on Group 01 at this level. However, at the level above, the parent groups 0 (urban, some arable preferentials) and 1 (rural, some woodland preferentials) have these influences reversed, which can be assumed is the stronger trend. Woodland species at this level are mainly represented in the non-preferentials and appear to be frequent in both Group 10 and Group 11.

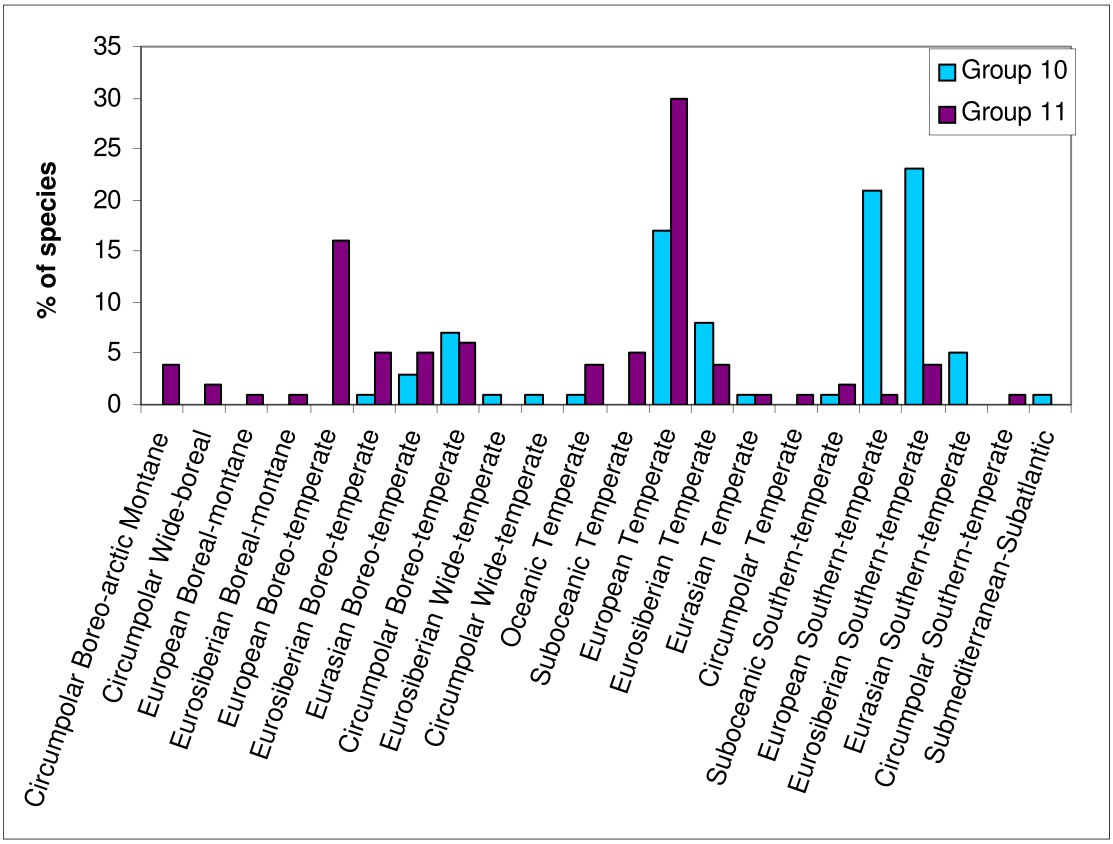
Group 10 can therefore be said to characterise the more habitat-rich parts of lowland Staffordshire (below 200 metres) outside the urban areas, with the majority of the biodiverse habitats present being woodlands. Relatively eutrophic open water is also likely to feature in these areas. Group 10 is also influenced by human activity, although not to the same degree as Group 0 tetrads. This is to be expected as Staffordshire is a populous County, with very few areas lacking at least a small village or hamlet.

Table 5.9 - Preferential species in Group 10 tetrads (above 50% occurrence)

Species	% of tetrads	Species	% of tetrads	Species	% of tetrads
Apium nodiflorum	64	Geranium dissectum*^	78	Solanum dulcamara	95
Arum maculatum	70	Geranium molle^	57	Tamus communis	63
Calystegia sylvatica+	63	Gnaphalium uliginosum^	57	Taxus baccata	59
Castanea sativa*	64	Persicaria amphibia	55	Veronica hederifolia*^	64
Euphorbia helioscopia*^	54	Ranuculus sceleratus^	54	Veronica persica^+	80
Euphorbia peplus*^	68	Sisymbrium officinale*^	83	Viola arvensis*^	51

KEY		
Arable	Waste ground	Woodland / planted
Grassland	Shade	Eutrophic water / mud
Indicator species	*Archaeophyte	+Neophyte
^Annual		

Figure 5.9 - Geographic attributes of preferential species for Groups 10 and 11



5.3.2.2 Group 11

The indicator species for Group 11 are *Briza media, Nardus stricta* and *Myrrhis odorata. Myrrhis odorata* is confined to northern areas of Staffordshire. It has a north-westerly distribution in England, and is a neophyte that is often found in association with habitation but may also be in remote situations. In Staffordshire, it tends to be found on road verges and in similar tall grassy areas, appearing to occupy similar situations to *Anthriscus sylvestris* and to some extent replacing it in the Staffordshire Peak District, particularly on calcareous soils. *Briza media* is a species of unimproved or semi-improved grassland and mires, usually with elevated base status and low or moderate soil fertility. It is confined to well-grazed grassland and open mires and is therefore not usually found in verges or taller grassland. *Nardus stricta* is only found in acidic conditions, where the nutrient status is low, that is in heathland or acidic grassland, usually on damp, peaty soils. It is tolerant of trampling and often forms the main component of the vegetation along heathland paths.

The preferentials for the group include heathland (or acidic grassland) species such as *Vaccinium myrtillus, Calluna vulgaris* and *Molinia caerulea.* There are also species of wetland among the preferentials, including *Valeriana dioica* and *Achillea ptarmica*, with species of open water being absent from the preferentials and somewhat rare among the non-preferentials. The largest proportion of preferentials comprises grassland species, for example *Saxifraga granulata, Euphrasia* species*, Alchemilla glabra* and *Alchemilla xanthoflora.*

Characteristic species of this group, compared to other groups at this level, were the species *Lathyrus linifolius, Oreopteris limbosperma, Alchemilla filicaulis* subspecies *vestita* and *Empetrum nigrum*. Of these, *Empetrum nigrum* is an upland species of dry moorland and mountain habitats. The others are all species that have declined in lowland areas due to habitat losses, and therefore may now appear to be more characteristic of uplands. Lowland heaths in Staffordshire tend to be rather dry and stony, with the underlying Sherwood Triassic sands and gravels exposed. The characteristic habitat for *Oreopteris limbosperma*, is the steep banks of watercourses in moorland, hence it is scarce on dry lowland heaths. *Eriophorum angustifolium* and *Eriophorum vaginatum* are also preferentials, which prefer damp, peaty soils, and are therefore mainly confined to upland areas.

Human-associated species, including archaeophytes and neophytes are only represented by two out of the 83 preferentials, *Centaurea montana* and *Cerastium tomentosum*, which are both neophytes. A non-urban archaeophyte, *Rumex pseudoalpinus*, is also preferential; this is confined to the Peak District in Staffordshire. Non-native species also make up a very small proportion (10% neophytes, <3% archaeophytes) of the non-preferentials and it is apparent that the tetrads in Group 11 are those with the least human influence of the whole County. The climate of this part of the County is much harsher than the lowland, with more severe winter weather. Gardening tends to be difficult, and it probably means that most 'new' species do not readily establish in the wild. An exception is *Acer pseudoplatanus*, a very resilient neophyte that was traditionally planted in the area to shelter property, which is present in 80% of Group 11 tetrads.

Woodland species feature strongly within the non-preferentials, and it is apparent that very few of the tetrads in this group lack woodland. This is also true of Group 10, and woodland is apparently a strong factor in Group 1 as a whole. This is clear from Table 5.1, Page 63)

The tetrads in Group 11 therefore appear to be characterised by species that are commoner in upland areas, and include species of heathland, wetland, woodland and grassland situations, suggesting upland areas with surviving semi-natural vegetation. The wide range of preferentials might suggest a lack of ecological coherence within the group. Table 5.6 shows this wide range is found in over half the tetrads, which probably reflects the complex nature of the geology and soil types in at least some of these parts of the County.

Group 11 is mainly situated in the north east of the County, with three tetrads from the open heathland parts of Cannock Chase (Sherbrook Valley). Most of these tetrads are at or above 200m in altitude; this appears mostly to reflect the absence of certain species in most lowland areas due to their exclusion by the more intensive us of the landscape, rather than a particularly characteristic 'upland' flora. The damper, colder climate of these upland areas does however appear to have an effect in the presence of species of moorland (e.g. *Oreopteris limbosperma*) and a relative scarcity of garden species.

Group 11 has few species of arable conditions, supporting the view that semi-natural habitats and relatively low intensity agriculture predominate in these areas. Group 11 represents the parts of the County above 200 metres, 'upland Staffordshire' which has a high proportion of semi-natural habitat, and low intensity agriculture.

5.3.2.3 Groups 10 and 11 summary

Group 10 is characterised by species of cultivation, such as *Veronica persica, Euphorbia peplus* and *Fallopia convolvulus*. It also has an apparently stronger human influence than Group 11 shown by species such as *Sisymbrium officinale* and *Syringa vulgaris*. Group 10 is found mainly in the north of the County, with additional tetrads around Cannock Chase and Lichfield and on the west side near Newport (Salop).

Group 11 has many species of semi-natural habitats, particularly species of grasslands ranging from acidic grasslands (*Nardus stricta, Lathyrus linifolius*) to calcicolous grasslands (*Briza media, Linum catharticum*). Its preferentials include many species of wetlands (*Epilobium palustre, Geum rivale*) and heathlands (*Vaccinium myrtillus, Calluna vulgaris)*. Overall, the species in Group 11 require much lower fertility than those in Group 10.

Group 11 appears to be less influenced by human habitation (than group 10), with archaeophyte and neophyte species being only weakly represented. Group 11 tetrads are mainly distributed in and around the Staffordshire part of the Peak District, around Leek and with three tetrads on the non-agricultural extensive heathland parts of Cannock Chase.

Table 5.10 - Preferential species in Group 11 tetrads (over 50% occurrence)

Species	% of tetrads	Species	% of tetrads	Species	% of tetrads
Achillea ptarmica	68	Euphrasia officinalis agg	61	Nardus stricta	78
Alchemilla glabra	56	Festuca ovina	96	Oreopteris limbosperma	55
Alchemilla xanthochlora	53	Geranium pratense	54	Persicaria bistorta	58
Blechnum spicant	75	Geum rivale	55	Petasites hybridus	72
Briza media	78	Juncus squarrosus	58	Pimpinella major	50
Calluna vulgaris	76	Lathyrus linifolius	65	Rhinanthus minor	63
Campanula rotundifolia	96	Leontodon hispidus	60	Rosa caesia	64
Carex caryophyllea	56	Linum catharticum	50	Senecio aquatilis	65
Carex flacca	80	Luzula multiflora	65	Ulex gall1	87
Dactylorhiza fuchsii	72	Luzula sylvatica	58	Vaccinium myrtillus	81
Danthonia decumbens	55	Molinia caerulea	63	Veronica officinalis	67
Epilobium palustre	68	Montia fontana	52		
Equisetum sylvaticum	67	Myrrhis odorata	85		

KEY			
Grassland	Base-rich	Shade	Indicator species
Heathland / acidic	Wetland	Woodland	

Table 5.11 - CSR strategy and Ellenberg values for Groups 10 and 11*

	Group 10	Group 11
Grime Strategy C/S/R	4/3/7	1/2/1
Light	6.5	6.9
Wetness	5.6	6.2
pH	6.8	4.9
Fertility	6.3	3.2

** values calculated using MAVIS as described in Section 4.3.5*

5.4 TWINSPAN level three

5.4.1 Groups 000 and 001

Group 00, the archetypical urban group, divides into two groups of rather unequal size, Group 000 with predominantly garden species as preferentials, and Group 001 with mainly wetland and open water indicators and preferentials (Figure 5.10 shows the distribution of tetrads).

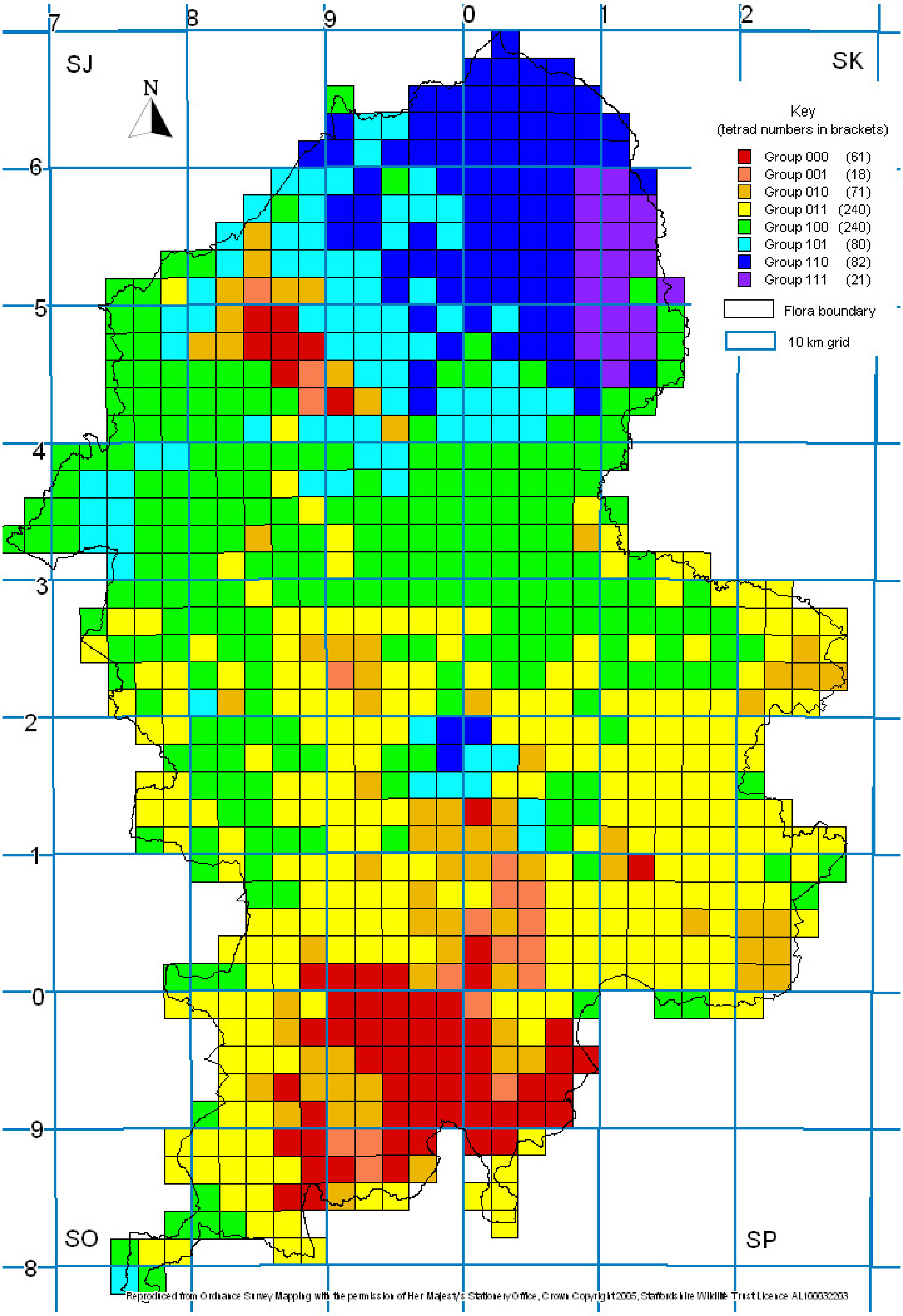
5.4.1.1 Group 000

Group 000 has 61 tetrads, representing a large proportion of Group 00, and lacking indicators. Its 37 preferentials include 22 species, such as *Erysimum cheiri, Campanula persicifolia* and *Meconopsis cambrica,* which are garden plants. The preferentials also include species of arable land: *Aphanes arvensis, Anchusa arvensis, Viola tricolor* and *Urtica urens,* these may also be found in other cultivated areas such as gardens and allotments. There are also species of walls: *Asplenium trichomanes, Mycelis muralis* and *Parietaria judaica*; these might indicate areas where at least part of the built environment is longer-established with older lime-based mortars which soften and allow plants to gain a foothold.

Analysis of the preferentials (Table 5.12) using MAVIS produced an aggregate score for competition (C), stress (S) and ruderality (R) of C2, S 3 and R 4 (figures rounded). This indicates that tetrads in the group experience a degree of disturbance, which would be expected in a predominantly urban area, with some influence of stress too. For Group 001, this ratio is C5:S6:R4, where stress tolerance is the main strategy, with some degree of competition, and ruderality is apparently less important than in Group 000.

The Ellenberg indicator values calculated for the preferentials for Group 000 show moderate values for light, moisture, pH and fertility, so these are probably not the determining factors in these tetrads. In urban areas other factors, such as high temperatures, may be a cause of stress, however Grime or Ellenberg values are not available in MAVIS for many of the preferentials in Group 000, so a detailed extrapolation of these results is perhaps unwise.

Figure 5.10 - Map showing third level of TWINSPAN analysis



Most of the wetland or canal species that are preferential for Group 001 are also present in Group 000 to some extent. The majority of the Group 000 tetrads do contain canals or other open water. It might be that canals in Group 000 tetrads tend to have a reduced species composition compared to Group 001. In two of the tetrads, for example, the canal comprises a flight of locks, which will inevitably restrict the available space for plants. Explanations such as this do not apply for all tetrads as in many areas the canal or other water has fewer apparent constraints. It appears that the overall distinguishing factor for Group 000 is the presence of a range of garden species.

The tetrads in Group 000 are found mainly in core urban areas throughout the Black Country (excluding west of Dudley and east of Walsall) and Stoke-on-Trent with single tetrads in Lichfield and Hednesford (on the south edge of Cannock Chase). These areas encompass the commercial centres of Wolverhampton, Hanley and Newcastle-under-Lyme; their inclusion is probably partly due to the presence of town parks (e.g. West Park in Wolverhampton) but also because these centres are small and the tetrads cover residential areas. Further west of Dudley, four more-rural tetrads are also included, although these have residential areas and formal gardens and / or a golf course. In general, these tetrads seem to be characterised by plants associated with human accommodation.

Table 5.12 - CSR strategy, Ellenberg values and NVC for Groups 000 and 001*

	Group 000	Group 001
Grime Strategy C/S/R	2/3/4	5/6/4
Light	6.7	7.0
Wetness	4.4	7.7
pH	6.9	5.5
Fertility	5.4	4.3

** values calculated using MAVIS with %cover recorded as % of tetrads in Group with species*

5.4.1.2 Group 001

Group 001 is rather small, with only eighteen tetrads, the smallest group at Level 3. The five indicators for Group 001 include: *Galium palustre, Cirsium palustre* and *Carex ovalis* - species frequently found on the margins of canals and other water. The other two indicators are *Eleocharis palustris* and *Dactylorhiza praetermissa,* which tend to be found in wetlands with somewhat elevated base status. The preferentials include mainly species of open water, for example *Potamogeton natans, Myriophyllum spicatum* and *Rorippa nasturtium-aquaticum* agg. There are also a number of species of wetlands or watersides such as *Carex nigra, Hypericum tetrapterum, Angelica sylvestris, Filipendula ulmaria* and *Eupatorium cannabinum*. Over half of the preferentials are species of open water or wetland situations. The preferentials also include species of drier grasslands such as *Leontodon saxatilis, Rhinanthus minor* and *Linum catharticum*. There are also species of heathland and acidic grassland, for example *Calluna vulgaris, Galium saxatile, Potentilla erecta* and *Festuca ovina*. A few weak preferentials are species of shade or woodlands, like *Teucrium scorodonia*, although most of the species of these habitats occur in the non-preferentials. The garden species present in Group 000 are very restricted in Group 001, usually appearing in five or fewer of the 18 tetrads.

This rather mixed range of species appears to indicate a number of urban tetrads with a strong water or wetland influence, with canals perhaps being the main distinguishing feature. Grassland appears also to be important, from a range of hydrological situations (as indicated above), and with a range of soil reactions (species include *Linum catharticum*, as well as acidic grassland species such as *Galium saxatile).* The overall calculated Ellenberg values indicate moderately acid conditions, low fertility and moist to damp soils in Group 001. While the values for fertility and light requirements are relatively similar in Group 000, the pH is closer to neutral and its soils appear to be characteristically dry. This may indicate that artificial substrates, such as brick and concrete rubble, predominate in the Group 000 tetrads, although the Sedgley and Dudley areas of the Black Country are on limestone.

Group 001 tetrads are found in the edges of the urban areas to the south of Dudley, the north of Sandwell Valley, Walsall centre and Rough Wood, parts of Stoke, Stafford and around Chasewater. These seem to be parts of the conurbations with surviving pre- and post- industrial land, which have species-rich wetlands. These areas were connected with canals as important transport routes for both raw materials and products. The tetrads are absent from Burton-upon-Trent and Tamworth in the east of the County, although both towns have canals and remnant grasslands, and industrial heritage. Both Burton and Tamworth are divided by relatively large rivers, and this might be a stronger influence in these areas. Both towns have also been extensively redeveloped, with the loss of most post-industrial land. Group 001 tetrads are also absent from the smaller towns such as Stone and Uttoxeter, however these do not have such a strong industrial heritage.

Group 001 probably therefore consists of tetrads with post-industrial habitat, and which lack many of the characteristic urban 'garden escape' plants. Group 001 is much less characterised by human accommodation than Group 000 and seems to represent a group of tetrads dominated either by less-intensively-used open spaces, often post-industrial in nature, or by relict countryside areas.

5.4.1.3 Groups 000 and 001 summary

Group 000 is the core urban group of the Black Country and Stoke-on-Trent, characterised by species of gardens, cultivation and walls. It is probably subject to considerable disturbance.

Group 001 appears to be mainly characterised by wetland and canal species, with species of semi-natural dry habitats, including heathland and grassland too. It lacks the garden species of Group 000, even though residential areas are present in most of the tetrads. Group 001 appears to be less disturbed than Group 000, although its habitats may be on post-industrial sites; this may mean that post-industrial sites in these areas have reached a stage that is relatively stable.

Groups 000 and 001 have not been examined further because Group 001 is the smallest group at this level, and the next level produces one group (Group 0000) with only five tetrads.

5.4.2 Groups 010 and 011

Group 01, the large group of predominantly agricultural, lowland parts of the County with a strong influence of human habitation, a southerly / south-easterly distribution and remnant woodlands or hedges, divides into Group 010 (71 tetrads) and Group 011 (240 tetrads) with an eigenvalue of 0.04. Group 010 indicators are mainly species of open habitats and include many neophytes, while Group 011 has only two preferentials, one from disturbed ground and the other from forestry plantations.

5.4.2.1 Group 010

Group 010 has seven indicators, six of which are species of open habitats, often on previously developed land: *Senecio squalidus, Fallopia japonica, Melilotus altissimus, Linaria vulgaris, Buddleja davidii* and *Melilotus officinalis*. With the exceptions of *Melilotus altissimus* and *Linaria vulgaris* these are all neophyte species (Preston *et al.*, 2002). That is, they are introduced species that are present in the wild as naturalised populations, which were first introduced after 1500AD (or only present as casuals before 1500 AD and subsequently re-introduced and naturalised). The remaining indicator, *Carex ovalis,* is a species of a range of habitats, including acidic grassland, wetlands and ruderal situations.

The preferential species are similar to the indicators, with a high proportion of neophytes (42%), such as *Linaria purpurea, Lysimachia punctata* and *Oenothera glazioviana*. A further 6% of preferentials are those whose status is difficult to determine as they are native species that are frequently grown in gardens outside their natural range and often escaping (e.g. *Persicaria bistorta, Sorbus aria*). By contrast, the non-preferentials only have around 6% neophytes and 3% species of indeterminate, but probably garden origin in Staffordshire.

The preferential species contain a number of wetland species such as *Juncus acutiflorus* and *Carex nigra*, grassland species such as *Carex flacca* and *Festuca ovina*, and species that tolerate a degree of disturbance and are usually found in open habitats such as *Odontites vernus* or *Centaurium erythraea*. There are three orchid species: *Ophrys apifera* (which usually occurs in areas that are subject to disturbance), *Dactylorhiza fuchsii* and *Dactylorhiza praetermissa*, which are both species of unimproved or semi-improved grasslands. The heathland species *Calluna vulgaris, Luzula multiflora* and *Nardus stricta* are also preferentials in Group 010, although *Erica* and *Vaccinium* species are absent from both preferentials and non-preferentials, meaning Group 010 may only contain remnant heathland or acidic grassland. All of the indicators and many of the preferentials are species of non-eutrophic habitats, the Ellenberg value calculated for the Group's preferentials for fertility is 4.7, indicating sites of intermediate fertility. Group 010 therefore appears to be a group that contains human-influenced tetrads that also have surviving semi-natural vegetation.

These tetrads are mainly found around the urban fringes of the Black Country, Stafford, Cannock, Tamworth and Stoke-on-Trent, in many areas including 'villages' that have become urbanised, such as Sedgley and Gornal (near Dudley), Penn and Whitwick (Wolverhampton) and Silverdale (Newcastle). In some places (e.g. Burton-upon-Trent, Stafford and Tunstall) most of the urban area is in Group 010; these tend to be towns with considerable open areas, or situated adjacent to open countryside.

Preferential species for Group 010 include some which are similar to those of Group 001, but it has a slightly wider range of grassland preferentials, and a more restricted range of open water species. This may indicate that canals are less of an influence in these tetrads. Canals are absent from around two-thirds of the tetrads, however the remaining third of tetrads do feature canals. Some of the canals are recognised for their aquatic species composition, such as the Cannock Extension Canal Site of Special Scientific Interest and Special Area of Conservation, so Group 010 is more likely to be defined by the presence of the neophytes / garden species, rather than by the paucity of its canals or wetlands.

In conclusion, Group 010 is defined by the presence of a number of garden and / or neophyte species, and includes wetland, open water and grassland components. Group 010 tetrads are found on the edges of urban areas, or in towns with areas that are more open or with better connection to the wider countryside. They appear to have surviving habitats in common with Group 001, and these are both areas where habitats have possibly survived better than in the core urban areas where redevelopment is prevalent (Group 000). These habitats have often been lost in the agriculturally improved rural areas too (Group 011).

Table 5.13 - CSR strategy and Ellenberg values for Groups 010 and 011*

	Group 010	Group 011†
Grime Strategy C/S/R	1/1/1	
Light	7.2	
Wetness	6.1	
pH	6.4	
Fertility	4.7	

** values calculated using MAVIS with %cover recorded as % of tetrads in Group with species*

†values were not calculated because there are too few preferentials

5.4.2.2 Group 011

Group 011 lacks indicator species; its only two preferentials are *Coronopus squamatus* and *Picea abies*; these are only present in 1/5 to ¼ of tetrads and so are weak preferentials. *Coronopus squamatus* is a lowland species of compacted ground, such as farmyards and gateways. *Picea abies* is an extensively planted forestry species, which can also naturally regenerate from seed. These species are recorded from less than 3% of Group 010 tetrads, Group 011 is therefore probably best defined within Group 01, as lacking the neophytes / garden species of Group 010.

The non-preferentials for Groups 010 and 011 include species of open water, grassland and wetland, for example *Apium nodiflorum, Centaurea nigra* and *Cirsium palustre.* This suggests that grassland, open water and wetland are present in Group 011 as well as in Group 010, although probably to a lesser extent.

Surprisingly the heathland of Highgate Common (SO88/89) is within Group 011, possibly because it is botanically rather poor compared to other heaths, such as Cannock Chase (mainly in group 1 tetrads), and has become somewhat fragmented and scrubbed over. Species totals for these tetrads are not particularly low, compared to other tetrads, indicating that recording effort has been reasonable in these areas. The analysis at fourth and fifth levels (Groups 0110, 0111, 01100, 01101, 01110 and 01111) does not show any apparent heathland character. It therefore seems likly that the tetrads simply do not have enough characteristic heathland / acidic grassland species to distinguish them, and were originally placed into Group 0, rather than Group 1 because of a preponderance of human-influenced species.

Group 011 is widely distributed in central and southern Staffordshire, with further tetrads in Stone, Uttoxeter and around Stoke. Group 011 represents intensively managed agricultural land with villages or small towns, with pockets of surviving semi-natural habitat in places.

5.4.2.3 Groups 010 and 011 summary

Group 010 has a number of garden species, and a relatively high proportion of species of semi-natural habitats, compared to Group 011. Group 010 is probably therefore a small group of more diverse tetrads compared to the bulk of lowland, intensively-farmed Staffordshire in Group 011. Group 010 is an urban periphery group, which is clear from the map, and has apparently strong affinities with Group 001.

Group 011 also contains species of semi-natural habitats, although these habitats in Group 011 are probably less extensive and / or poorer than those in Group 010. Overall, Group 011 is species-poor compared to other groups at this level, and appears to be dominated by intensive agriculture.

5.4.3 Groups 100 and 101

Group 10, the more habitat-rich parts of lowland Staffordshire outside the urban areas, with woodlands and eutrophic open water as the most prominent habitats, divides into Group 100 (240 tetrads) and Group 101 (80 tetrads).

5.4.3.1 Group 100

Group 100 has one indicator, *Arum maculatum*, which is a species of shade. Preferentials also include shade species, such as *Chaerophyllum temulum* and *Tamus communis*, as well as grassland species such as *Agrimonia eupatoria, Galium verum* and *Cruciata laevipes*. Most of the preferentials could be said to occur in rough grassland or hedges, and so might be associated with road verges. Group 100 is a large group with 240 tetrads and continues to dominate lowland central and northern Staffordshire even at this level.

Species of heathland and / or acidic grassland habitats are largely absent from Group 100. It also appears to lack the apparent strong influence of semi-natural habitat that applies to Group 101, possibly because the soils are deeper and have been agriculturally improved, leaving less remnant habitat. Its preferential species include species of arable or disturbed soils: Anagallis arvensis, Solanum nigrum and *Papaver rhoeas*, which Species of wetlands, open water, woodlands and grasslands are prominent in the non-preferentials, however, so these habitats are likely to be present in Group 100.

Table 5.14 - CSR strategy and Ellenberg values for Groups 100 and 101*

	Group 100	Group 101
Grime Strategy C/S/R	5/6/6	4/7/4
Light	5.8	6.6
Wetness	4.9	6.0
pH	6.8	4.7
Fertility	5.5	3.9

** values calculated using MAVIS with % cover recorded as % of tetrads in Group with species*

5.4.3.2 Group 101

Group 101 has 80 tetrads, with *Deschampsia flexuosa, Galium saxatile, Festuca ovina, Nardus stricta, Calluna vulgaris* and *Vaccinium myrtillus* as indicators. These are all species of heathland and / or acidic grassland. The preferentials for the group include species of grasslands (*Campanula rotundifolia, Potentilla erecta,*), woodlands (*Dryopteris affinis, Luzula sylvatica*) and wetlands (*Cardamine amara, Carex ovalis*); around a quarter of the preferentials are species that prefer acidic conditions. Group 101 therefore appears to have a strong acidic or heathland influence, with probably a higher proportion of semi-natural habitats than Group 100.

The tetrads from this group are mainly situated between Stoke and Leek and to the south- and west- of Stoke. There are scattered tetrads around Cannock Chase, in the Wyre Forest, at Doley Common, Gentleshaw Common, and around Loggerheads and Maer Hills. Nearly all of these scattered tetrads have Sites of Special Scientific Interest (SSSIs) within them, and / or heathland. In the main areas for the Group, the altitude is above 200 metres (as for Group 11). It is therefore probable that in these areas the acidic bedrock is closer to the surface in places, giving thinner soils that are less suitable for agricultural improvement.

5.4.3.3 Groups 100 and 101 summary

Both groups have species of semi-natural habitats, including grasslands, woodlands and wetlands. Group 101 also has species of heathlands, and it is these that distinguish it from Group 100. Group 101 tetrads therefore have, at least in places, thin acidic soils. Group 100 has species of arable land and hedges or road verges and appears to represent the more agricultural areas of Group 1 tetrads.

5.4.4 Groups 110 and 111

Group 11, the parts of the County above 200 metres, 'upland Staffordshire' with a high proportion of semi-natural habitat, and low intensity agriculture, divides into Group 110 (82 tetrads) and Group 111 (21 tetrads).

5.4.4.1 Group 110

The indicator species for Group 110 is *Vaccinium myrtillus*; preferential species include *Nardus stricta, Rumex acetosella, Deschampsia flexuosa* and *Oreopteris limbosperma* (all species of heathland and other acidic habitats) and *Galium palustre, Achillea ptarmica, Carex nigra, Carex echinata, Stachys palustris* and *Valeriana dioica,* which are all species of wetlands. Species of wet, heathy conditions are well represented in the preferentials too, including *Eriophorum angustifolium, Eriophorum vaginatum* and *Erica tetralix*. There are a few species of more shaded habitats among the preferentials for group 110, such as *Ceratocapnos claviculata, Dryopteris affinis* and *Equisetum sylvaticum*; these all prefer acidic situations. It therefore appears that the Group has a preponderance of wetland and / or acidic habitats.

The location of these tetrads is mainly in the north of the County, with three tetrads from the open heathland parts of Cannock Chase (Sherbrook Valley); the Group is not found on the limestone to the northeast of the County.

Table 5.15 - CSR strategy, Ellenberg values and NVC for Groups 110 and 111*

	Group 110	**Group 111**
Grime Strategy C/S/R	5/ 6/ 4	2/ 4/ 3
Light	6.8	6.6
Wetness	7.2	4.6
pH	4.5	6.9
Fertility	3.7	4.3
NVC	MG15 / M23	CG8 / CG2

** values calculated using MAVIS as described in Section 4.3.5.*

5.4.4.2 Group 111

Group 111 has only 21 tetrads; these have mainly indicators of limestone grassland, including *Koeleria macrantha, Thymus polytrichus, Sanguisorba minor* subspecies *minor* and *Carduus nutans*. The other indicator is *Aphanes arvensis* aggregate, which is a winter annual usually found in grassland on very thin soils. Many of the preferentials are also calcicoles of grassland habitats, such as *Helianthemum nummularium, Knautia arvensis* and *Gentianella amarella*. The calculated value for pH is 6.9, which is defined as an 'indicator of weakly acid to weakly basic conditions; never found on very acid soils'(Hill *et al.*, 1999). The NVC communities with the closest matches to the preferentials are the calcicolous grassland types CG8 (*Sesleria albicans – Scabiosa columbaria* grassland) and CG 2 (*Festuca ovina – Avenula pratensis* grassland). It is not possible to infer that Group 111 contains these communities because the species have been recorded from many different locations; these matches simply demonstrate that the Group has a strong component of calcicolous grassland species (indeed CG8 is confined to lowland Durham). CG2, however, is found in the north-east of Staffordshire, and it is likely that some of the tetrads in Group 111 do contain this community.

The Group also has preferentials that are associated with base-rich woodland, such as *Sanicula europaea, Viola reichenbachiana* and *Galium odoratum*. Woodland and shade plants only make up around one-fifth of the preferentials in total, the remainder being nearly all grassland species. This is supported by the calculated value for light of 6.6, showing that the preferentials are mainly species of generally well-lit places.

The eigenvalue for this division is the strongest so far and these tetrads are strongly associated with the limestone of the Hamps, Manifold and Dove Valleys and the Cauldon area in SK05, SK15, SK04 and SK14. This area, excluding Cauldon, has flat plateaus with incised valleys, where most of the habitat is associated with the valleys, as the plateaus have been agriculturally improved. In the valleys, woodlands tend to be located on the steepest slopes with grassland on the fringes of the woodland, usually confined to thin soils.

5.4.4.3 Summary

Group 111 has mainly indicators of dry, base-enriched or calcicolous situations, and is confined to the limestone parts of SK05, SK15 and with one tetrad in SK04. Group 110 has one indicator, *Vaccinium myrtillus*, which is a species of acidic habitats such as heathland and the edges of acidic woodlands. Most of the preferentials for Group 110 are species of acidic situations, ranging from dry to wet conditions. These include *Calluna vulgaris, Carex pilulifera, Carex binervis, Eriophorum vaginatum* and *Blechnum spicant*. Group 110 also has species from wetlands and water ranging from acidic (*Carex rostrata, Myosotis secunda*) to neutral conditions (*Glyceria maxima, Carex acutiformis*). None of the preferential species for Group 110 has an Ellenberg pH reaction above 7 (weakly acid to weakly basic) (Hill *et al.*, 1999).

5.5 TWINSPAN level 4

5.5.1 Groups 0000 to 0011

The subdivisions of Groups 000 and 001 are not examined in this section because they do not provide further useful elucidation of the areas covered by the Level 3 groups.

5.5.2 Groups 0100 and 0101

Group 010, the lowland tetrads with considerable human influence and surviving habitat from the edges of urban areas, divides into Group 0100 (28 tetrads) and Group 0101 (43 tetrads), with an eigenvalue of 0.055 (Figure 5.11).

Group 0100 lacks indicator species; its somewhat weak preferentials include tree species that are used in ornamental planting schemes, for example *Alnus incana* and *Cornus sericea*, and heathland species such as *Vaccinium myrtillus* and *Nardus stricta*. The indicator species for Group 0101 are species of shade: *Arum maculatum, Tamus communis, Brachypodium sylvaticum* and *Glechoma hederacea*. Many of the preferentials are also species of shade including *Mercurialis perennis* and *Viola riviniana*, but also include species of wetland and open water such as *Apium nodiflorum* and *Filipendula ulmaria*.

The spatial distribution of these two groups (Figure 5.12) appears marked, with Group 0100 confined to the Cannock area and Stoke, with one tetrad in Stafford and one in Blackheath. Group 0101 is found mainly in Burton, Tamworth, west of the Black Country and scattered in smaller villages. It is likely that these two groups represent the dry acidic and woodland / wetland components of Group 010 respectively.

Figure 5.11 – Dendrogram showing Group 0 and its sub-groups

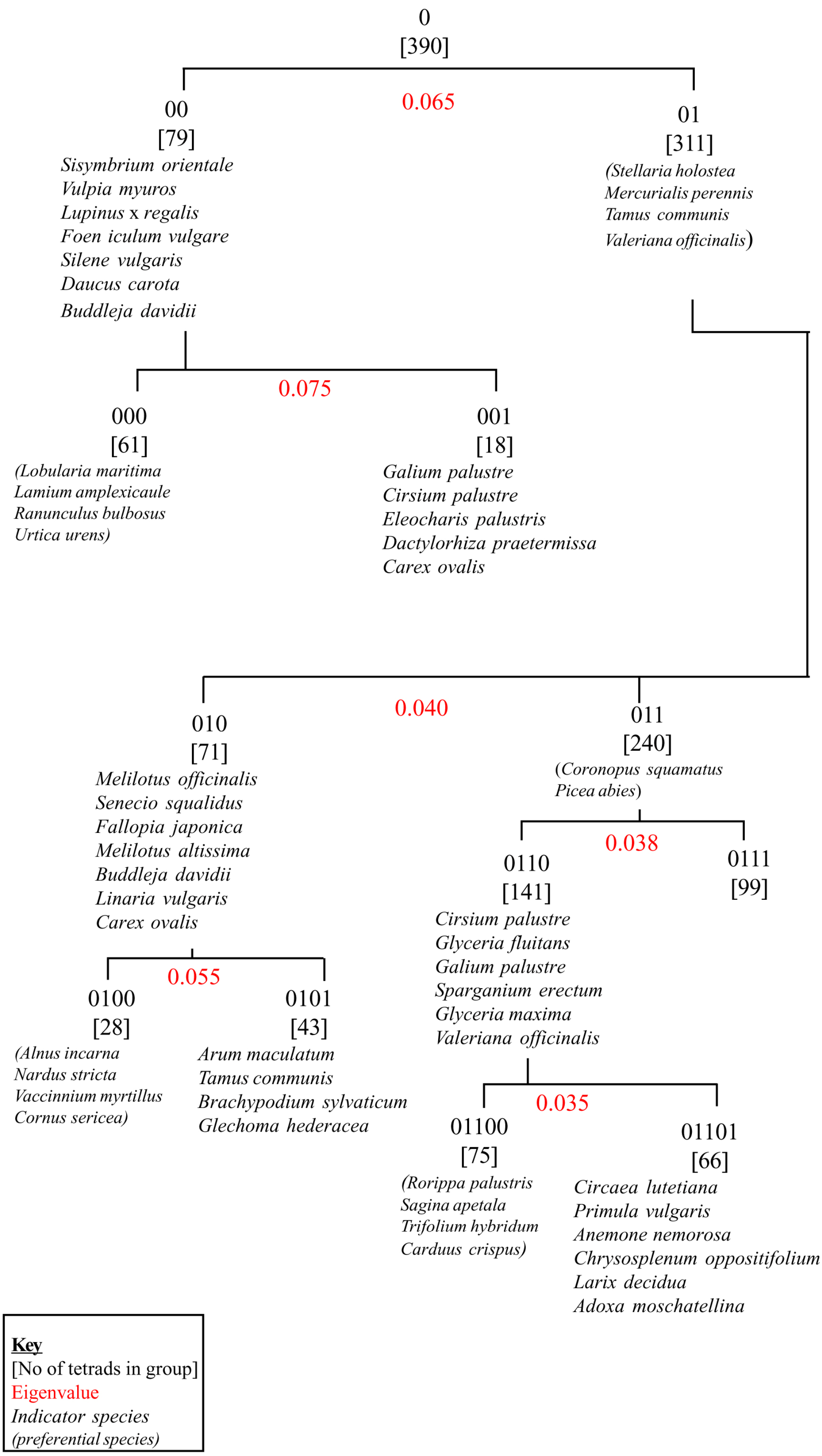
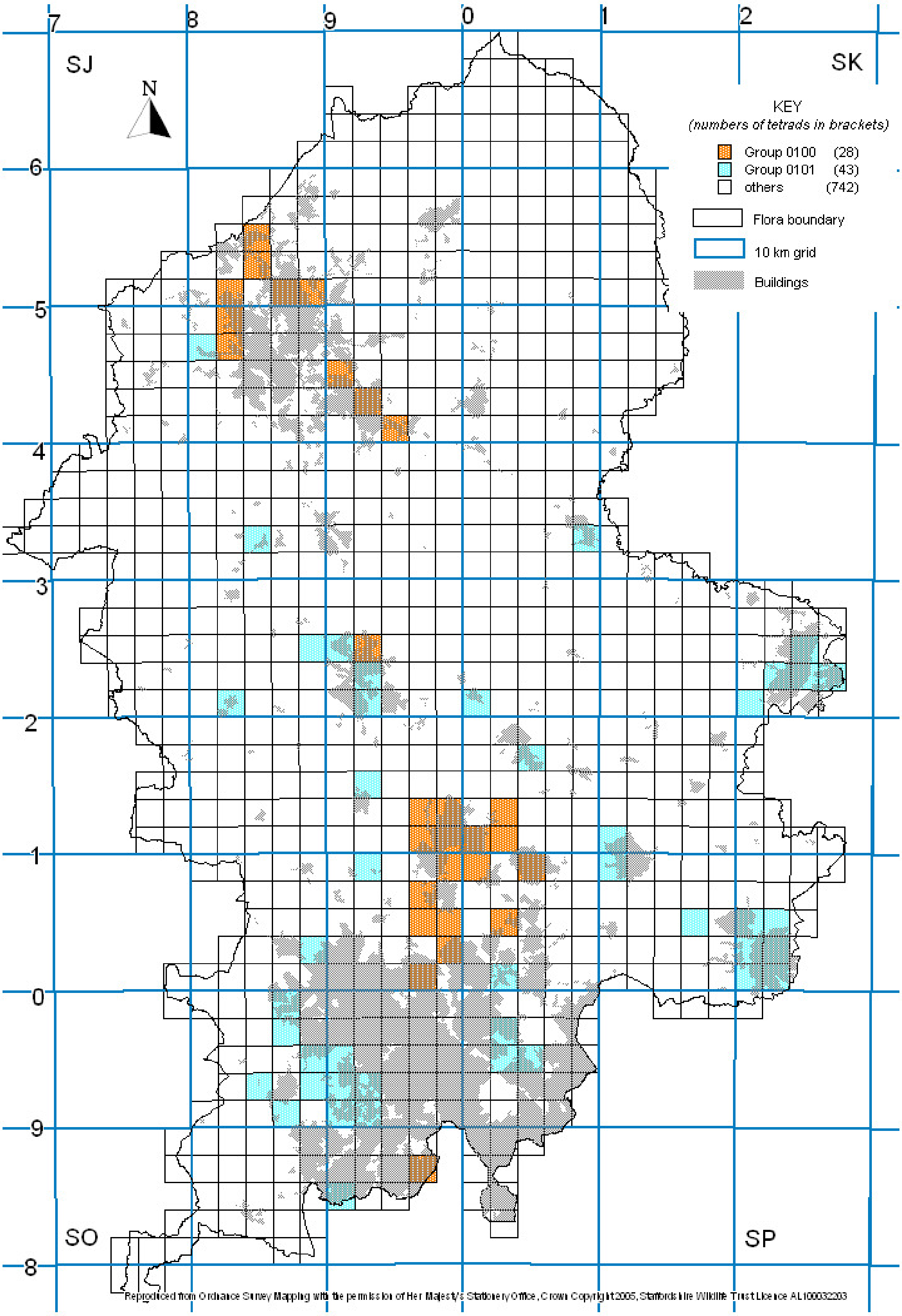


Figure 5.12 - Groups 0100 and 0101



5.5.3 Groups 0110 and 0111

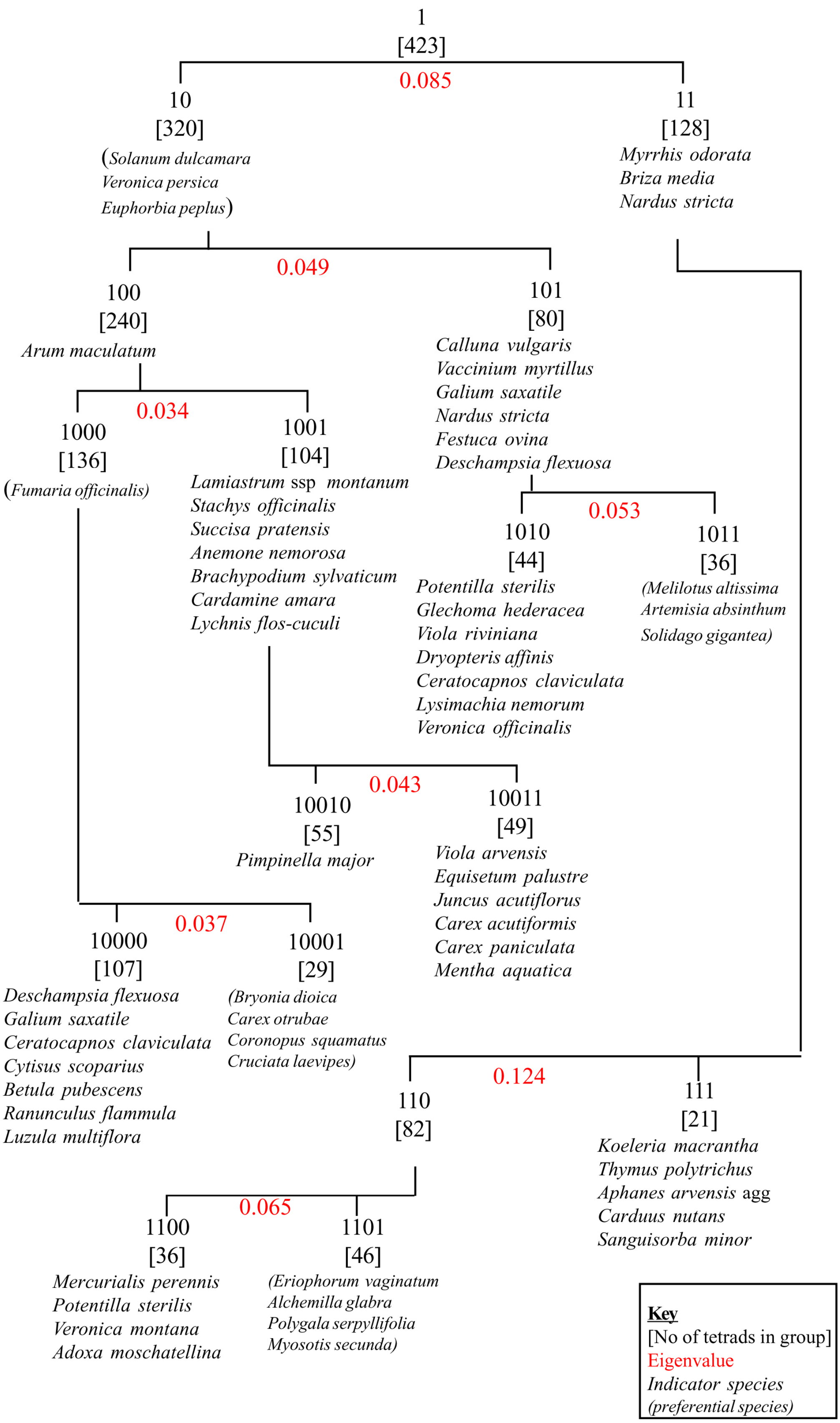
Group 011, the lowland, rural, agriculturally intensive group, divides into Group 0110 (141 tetrads), which has wetland and water indicators, and Group 0111 (99 tetrads), which does not have indicators or preferentials. Both groups are scattered across the south part of the County, with no obvious distribution patterns, and therefore no map has been produced for this division.

Group 0110 has *Galium palustre, Glyceria maxima, Cirsium palustre, Glyceria fluitans, Valeriana officinalis* and *Sparganium erectum* as indicators. This implies that the group has open water and / or wetland as a common factor.

Group 0111 does not have indicators or preferentials, and can therefore only be defined as having a lower incidence of wetland or open water species. The preferentials for Group 0110 rarely appear in more than 25% of the Group 0111 tetrads, indicating that the tetrads either lack open water or wetland, or that these habitats where present have an incomplete complement of species.

Comparison with maps showing open water, rivers and canals does not appear to show any clear differences between the two groups. Group 0110 may have a slightly greater association with larger rivers, and thus possibly floodplains. All of the indicator species and many of the preferentials for the group would be suitable for floodplain situations where wetlands are found.

Figure 5.13 – Group 1 and its sub-groups



5.5.4 Groups 1000 and 1001

Group 100 (the large lowland, and less habitat-rich component of Group 10), divides into Group 1000 (136 tetrads) and Group 1001 (104 tetrads), with an eigenvalue of 0.034 Figure 5.13).

Group 1001 has woodland, grassland and wetland species as its indicators, *Lamiastrum galeobdolon* subspecies *montanum, Anemone nemorosa, Brachypodium sylvaticum, Stachys officinalis, Succisa pratensis, Cardamine amara* and *Lychnis flos-cuculi*. These are all species of established semi-natural habitats.

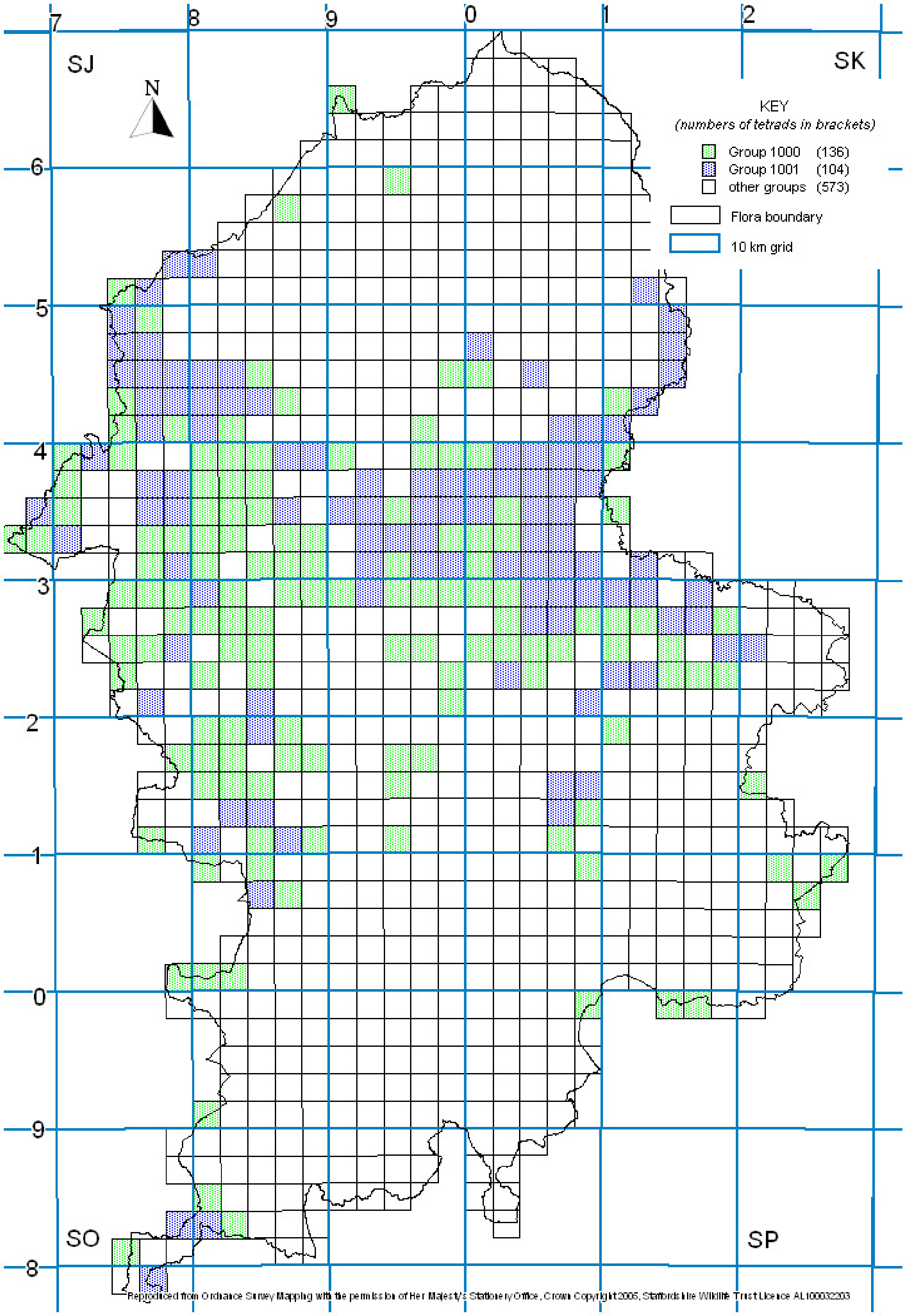
A small proportion of the preferentials are species of acidic conditions, such as *Lysimachia nemorum* and *Carex nigra*, both of which have an Ellenberg value of 4 for pH (Hill *et al.*, 1999), however typical heathland species such as *Calluna vulgaris* are absent from preferentials and non-preferentials. Most of the preferentials are species of neutral to base-rich soils, with Ellenberg values of 7 for pH, such as *Pimpinella saxifraga* and *Primula veris*.

Group 1001 is mainly situated somewhat to the north and east of Group 1000 (Figure 5.14). Its tetrads include those with Allimore Green Common SSSI, Mottey Meadows National Nature Reserve, the Wilderness and Vermin Valley SSSI, part of the Wyre Forest and Wrinehill Wood (a rather rich ancient woodland), and it appears that many tetrads have a preponderance of SSSI woodlands or grasslands. In some cases, the tetrads have Sites of County Biological Importance, and it certainly appears that there is a greater proportion of designated sites within Group 1001 than within Group 1000. Where designated sites are lacking in Group 1001, an effort to survey for habitats might be rewarded.

Group 1001 appears therefore to represent the non-acidic, habitat-rich component of Group 10 in parallel with the acidic habitat-rich component Group 101. Habitats in these tetrads, however, exert a weaker effect in the data, being masked by the species components of the predominant 'slightly above average' tetrads in its parent group, Group 100.

Group 1000 has only one preferential, *Fumaria officinalis*, a species of cultivation. This is a weak preferential, occurring in only 32% of tetrads. This suggests that this group can best be defined as being poorer in the species of Group 1001, and poorer in the corresponding habitats as well. Group 1000 tetrads do have Sites of County Biological Importance, although they mainly lack Sites of Special Scientific Interest. The SBIs in Group 1000 tetrads are heathy conifer plantations, such as Swynnerton Park, and parklands including Teddesley Park and the Chillington estate. Parkland SBIs in Staffordshire are designated for their veteran trees, and usually have intensively managed grassland lacking in botanical diversity.

Figure 5.14 – Groups 1000 and 1001



5.5.5 Groups 1010 and 1011

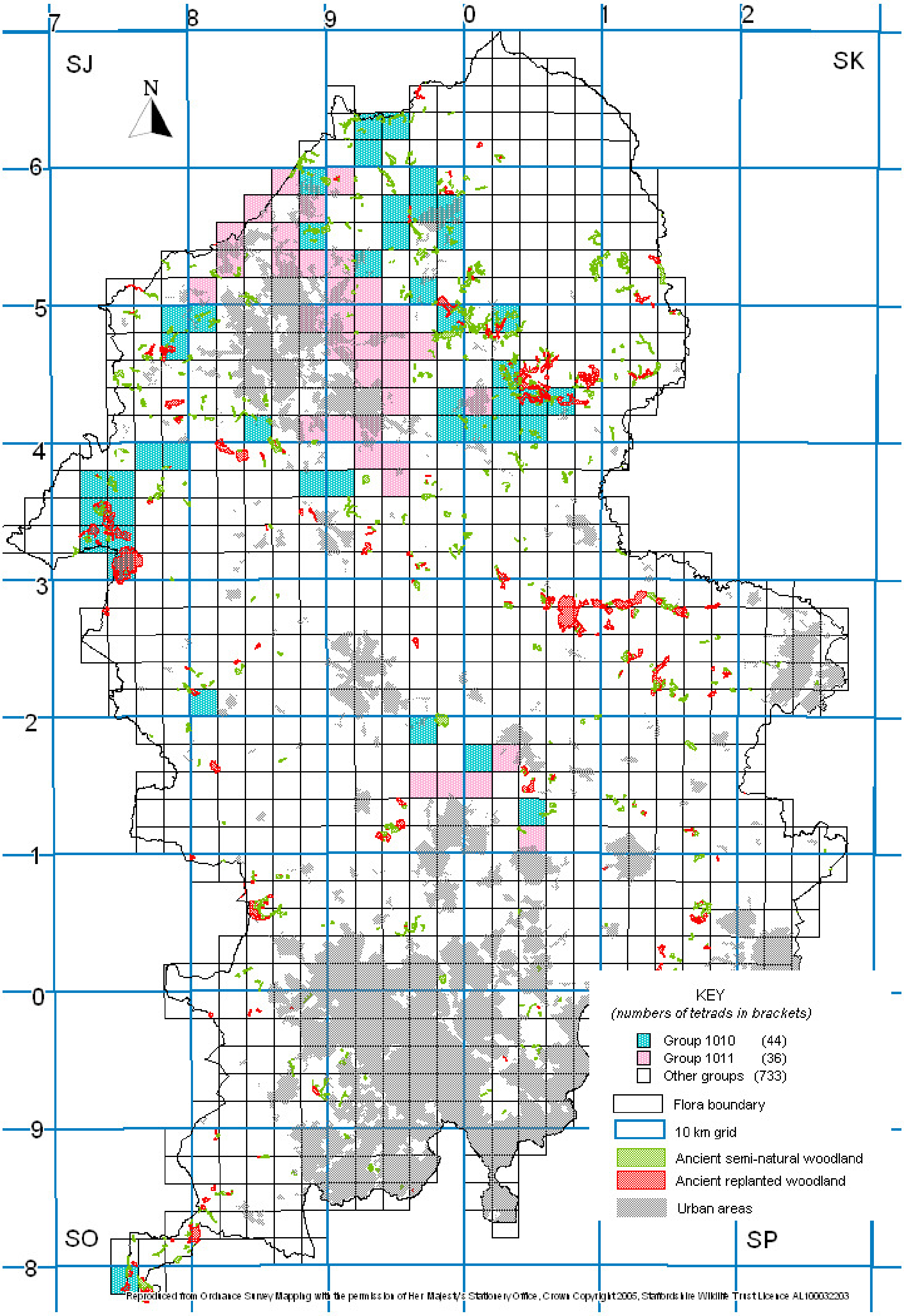
Group 101, the heathy habitat-rich lowland Staffordshire group, divides into Group 1010 (44 tetrads) and Group 1011 (36 tetrads), with an eigenvalue of 0.053.

Indicators for Group 1010 include *Glechoma hederacea, Viola riviniana, Dryopteris affinis, Lysimachia nemorum* and *Ceratocapnos claviculata*, which are all species of woodland or shade. *Potentilla sterilis* and *Veronica officinalis* are also indicators. The preferentials for the Group are also predominantly shade and woodland species, such as *Rumex sanguinea* and *Circaea lutetiana*. Figure 5.15 shows Groups 1010 and 1011 with ancient woodland, and indicates that ancient woodland is much more prevalent in Group 1010, than in Group 1011. Other preferentials for Group 1010 include mainly wetland species (*Cardamine amara, Ajuga reptans, Lychnis flos-cuculi*), with *Veronica officinalis,* which may be found in acidic grassland or heathland.

Preferentials for Group 1011 are mainly species of urban areas, such as *Melilotus altissimus, Oenothera glazioviana* and *Solidago gigantea*. Urban species did not form a strong component of Group 101, however tetrads from Group 1011 are situated closer to urban areas than those from Group 1010, so this distinction might be expected. These are all weak preferentials, however, and Group 1011 may also be defined as having fewer of the Group 1010 preferentials, and correspondingly less woodland as indicated in the map. Cheadle, which so far has evaded classification as an urban area, now appears in the more urban of the two groups, while the two Leek tetrads remain in the rural group.

Group 1010 therefore appears to be the more rural component of Group 101. Tetrads from this group are mainly from the rural areas to the southwest and northeast of Stoke, appearing to be less urban compared to Group 1011. They also usually have blocks of woodland, which are often lacking in Group 1011 tetrads.

Figure 5.15 – Groups 1010 and 1011, showing ancient woodland

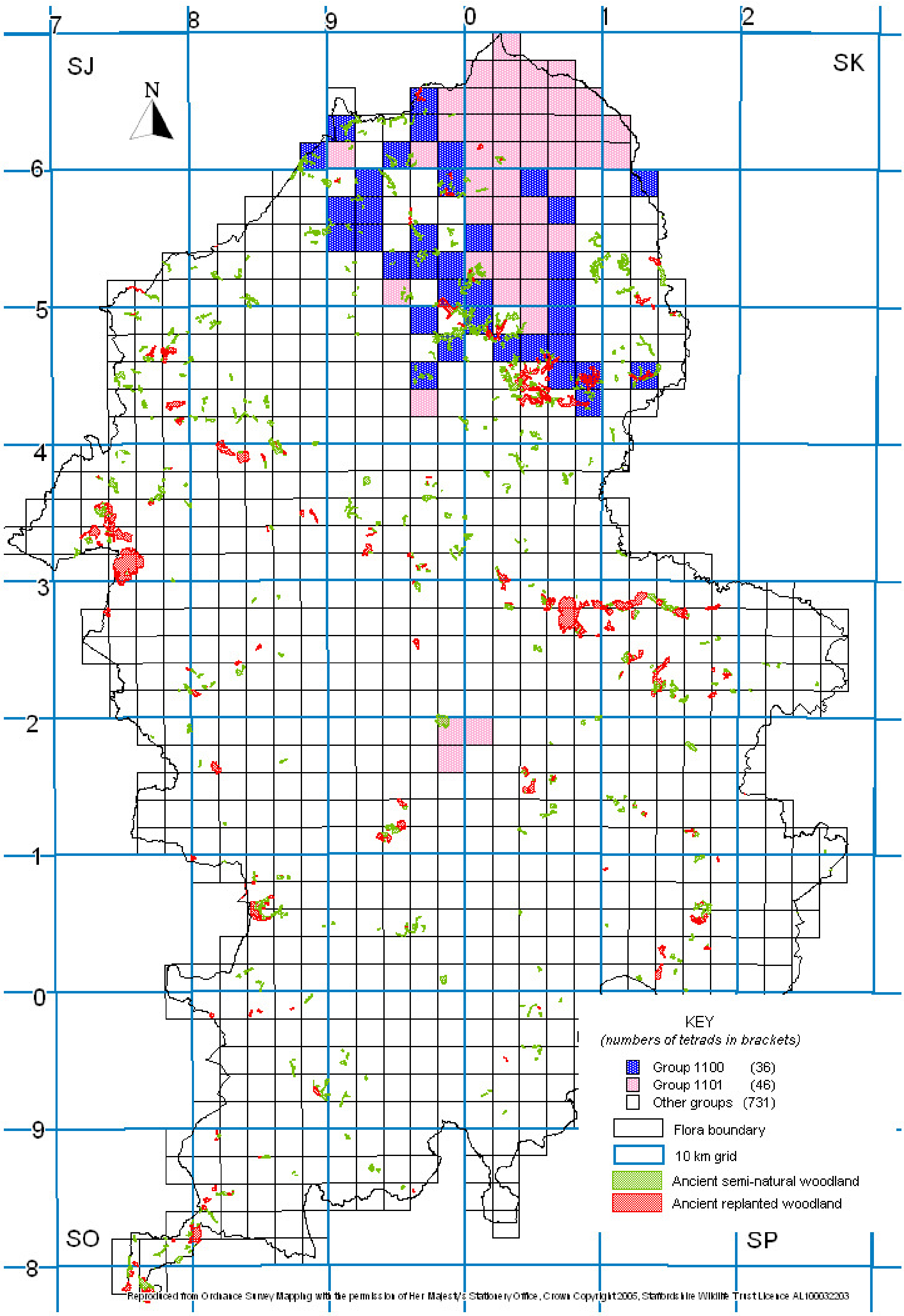


5.5.6 Groups 1100 and 1101

Group 110, the habitat-rich upland areas that lack limestone, divides into Group 1100 (36 tetrads) and Group 1101 (46 tetrads). Indicators for Group 1100 are *Mercurialis perennis, Veronica montana, Adoxa moschatellina* (woodland), *Potentilla sterilis* (grassland) and *Solanum dulcamara* (damp and disturbed conditions). Its preferentials include a similar mix of woodland species (*Circaea lutetiana, Viburnum opulus, Carex remota*), species of open water and margins (*Impatiens glandulifera, Glyceria notata*) and grassland species (*Potentilla sterilis, Pimpinella saxifraga*), with woodland species tending to be the strongest preferentials. The group appears to be associated with ancient woodland as shown in Figure 5.16, compared to Group 1101 where woodland is much less apparent.

Group 1101 has moorland species as the majority of its preferentials, these are: *Eriophorum angustifolium, Eriophorum vaginatum, Narthecium ossifragum, Empetrum nigrum, Carex echinata* and *Erica tetralix*, most of which require wet conditions. In addition, there are species of more grassy areas, including *Viola lutea*, *Alchemilla glabra, Agrostis vinealis* and *Polygala serpyllifolia. Ranunculus omiophyllus* and *Rosa mollis* are also preferentials. Both species are found in the habitats mentioned, however their British distributions are interesting in this context, the former has a strong western distribution, while the latter has a strong northern distribution. This perhaps emphasises the situation of Group 1101 tetrads as a northern, upland group. Group 1101 appears to have thinner, poor soils while Group 1100 with its wider range of habitats appears to indicate richer soils and possibly less upland conditions.

Figure 5.16 – Groups 1100 and 1101, showing ancient woodland



5.5.7 Groups 1110 and 1111

Group 111, the limestone group, divides strongly at the next level, with an eigenvalue of 0.104.

A small group of six tetrads forms Group 1110; the indicators for this Group are *Achillea ptarmica, Galium palustre, Juncus articulatus, Ranunculus flammula, Epilobium palustre* and *Galeopsis tetrahit* aggregate; its preferentials include species of wetland (*Succisa pratensis, Carex nigra* and *Carex panicea*), woodland (*Circaea lutetiana*) and heathland (*Calluna vulgaris*).

Group 1111 (15 tetrads) has only preferentials; these lack species of heathland or acidic habitats and have far fewer wetland species. Strong preferentials include *Ribes alpinum, Origanum vulgare, Veronica hederacea, Hypericum hirsutum, Asplenium trichomanes* and *Phyllitis scolopendrium*. Most of these are limestone plants, as expected for the Group. Although the 'New Atlas of the British Flora' (Preston *et al.*, 2002) indicates that it is a lowland species, *Ribes alpinum* is confined to the Peak District part of Staffordshire and is present as a native species, rather than a garden escape. *Asplenium trichomanes* and *Phyllitis scolopendrium* are species of rocky areas or walls.

The tetrads from Group 1110 are from the Weaver Hills area around Stanton, which is known for its complex mosaic of habitats, ranging from limestone grassland to moorland. The remaining tetrads from Group 1111 are all from the limestone part of the Peak District – the Hamps Manifold and Dove Valleys – where the geology is predominantly limestone and the semi-natural habitats are mainly limestone grassland and woodland. It appears that the division reflects the differences between the complex Weaver Hills area and the more straightforward limestone Peak District, even though both areas are rich in semi-natural habitats.

Figure 5.17 – Groups 1110 and 1111

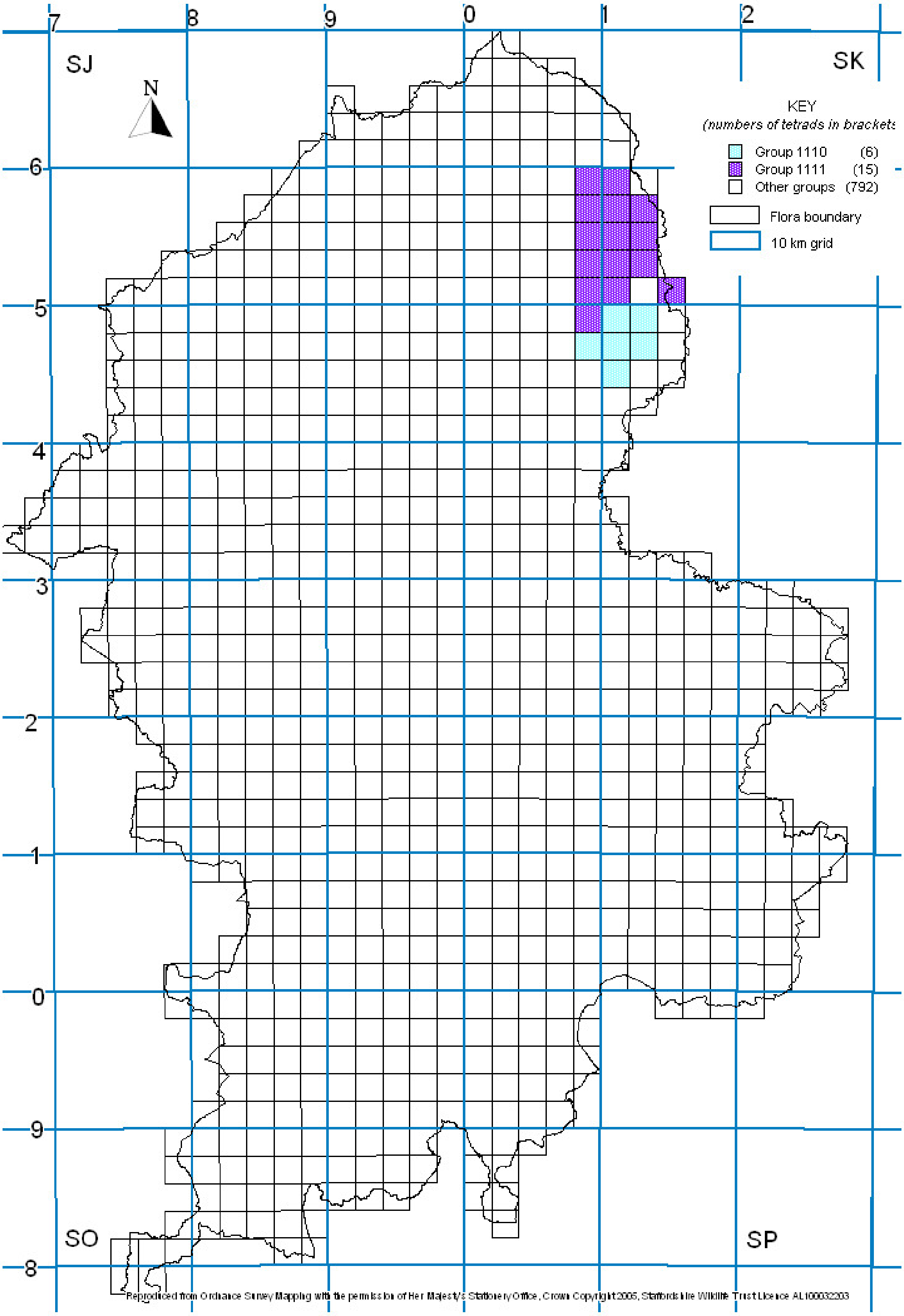


Table 5.16 - Summary of TWINSPAN results

<table>
<tr><td colspan="8">Group 0
Archaeophyte, ruderal
Lowland – southern and eastern UK characteristics
Human influence / urban and arable habitats / rural tetrads agriculturally improved
Open water and margins also present</td></tr>
<tr><td colspan="4">Group 00
Archetypical urban
Gardens / canals / planted trees</td><td colspan="4">Group 01
Human-influenced rural
Shade /woodland / hedges</td></tr>
<tr><td colspan="2">Group 000
Core urban
Gardens / cultivation / walls</td><td colspan="2">Group 001
Urban fringe
Post-industrial wetlands, canals, heaths and other habitat</td><td colspan="2">Group 010
Urban fringe
Residential areas - gardens and semi-natural habitats</td><td colspan="2">Group 011
Intensive agriculture</td></tr>
<tr><td colspan="2">Not examined</td><td colspan="2">Not examined</td><td>Group 0100
Base-poor habitat Planting schemes</td><td>Group 0101
Shade and wetland habitats</td><td>Group 0110
Wetland and open water, possibly on floodplains.</td><td>Group 0111
Lacks wetland / open water</td></tr>
<tr><td colspan="8">Group 1
Native species
Upland – northern and western UK characteristics
Semi-natural habitats - woodland, grassland, heathland and wetland
Low agricultural intensity, less arable, less developed</td></tr>
<tr><td colspan="4">Group 10
Human / arable / urban</td><td colspan="4">Group 11
Semi-natural / upland</td></tr>
<tr><td colspan="2">Group 100
Agriculturally improved / restricted semi-natural habitat</td><td colspan="2">Group 101
Base-poor habitats, probably on thinner soils, elevated altitude</td><td colspan="2">Group 110
Mainly base-poor and wetland habitats, upland</td><td colspan="2">Group 111
Limestone</td></tr>
<tr><td>Group 1000
Lacks habitat and botanically diverse designated sites</td><td>Group 1001
Semi-natural habitat, designated nature conservation sites</td><td>Group 1010
Woodland</td><td>Group 1011
Urban influence stronger, lacks woods</td><td>Group 1100
Habitat-rich, ancient woodland. Richer soils, upland fringe</td><td>Group 1101
Moorland, upland, thin soils</td><td>Group 1110
Complex of habitats includes wetland and heathland</td><td>Group 1111
Limestone area. Grassland & woodland habitats</td></tr>
</table>

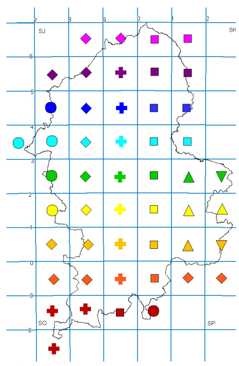
6 CANOCO ANALYSIS

6.1 Principal Components Analysis of species and tetrad data

When Detrended Correspondence Analysis (DCA) was used to analyse the species data, the gradient length for axis one was 2.341, indicating that the species were responding linearly to gradients. It was therefore decided to use Principal Components Analysis (PCA) for analysis of the species data.

Eigenvalues throughout are rather low, indicating that the trends differentiating between tetrads are not strong. This is as expected because the data do not contain any abundance measurements and each tetrad (2km square) is likely to contain a range of different habitats. Of these habitats, some are common throughout the areas sampled, for example agricultural grassland. A number of other habitats are common through most areas, such as hedgerows (although absent from moorland) and woodland (also largely absent from moorland).

Note: In the Figures for the following Sections, an inset Figure (right) appears that is intended to give a quick visual guide to the colour codes for tetrads within the 10 km squares. It was generated using MapInfo, which produces slightly different symbols and colours to CanoDraw, so where space allows, the CanoDraw tetrad key is retained as well. The tetrad key remains the same throughout the Figures, so it is hoped that its occasional absence from scatter diagrams does not present problems.



Where species name abbreviations are shown in diagrams, the species were reduced using the 'inclusion rules' option in CanoDraw; the percentage selected represents the contribution of the two axes to explaining the species abundances (ter Braak and Šmilauer, 2002), and is shown on each figure, with the resulting number of species displayed.

6.1.1 Axis 1

The results for the PCA analysis for Axes 1 and 2 are shown in Figures 6.1 to 6.2. Indicative colour coding has been used for species for clarification; some species fall into several habitat categories, but only one has been used.

In Figure 6.1, on the left hand side of the axis, species with a low score, are species of uplands and / or unimproved habitats, such as *Alchemilla glabra, Oreopteris limbosperma, Carex binervis, Vaccinium vitis-idaea* and *Lathyrus linifolius*. *Alchemilla glabra* is 'almost absent from England south of the Peak District' (Stace, 2003); most of these species have a strong north and west distribution in the UK. Species on the right side of the axis tend to have a southern and eastern distribution, including *Hordeum murinum* and *Lactuca serriola*.

On the left hand side are also species of woodland, including *Oxalis acetosella, Veronica montana* and *Athyrium filix-femina*. Many species are species of wetlands, such as *Cirsium palustre* and *Valeriana officinalis*. There are fewer species of open water than on the right hand side, and most of these, such as *Equisetum fluviatile,* are found in wetland situations too. Species of muddy pond margins, including *Glyceria declinata, Glyceria notata* and *Ranunculus hederaceus* are on the right of the axis, suggesting that cattle trampled pastures are present in these tetrads. Apart from the latter three species, most species are found in low nitrogen situations, compared to those from the right side of the axis, which are mainly species of intermediate to high nitrogen requirement, for example *Artemisia absinthum* (Tables 6.2 and 6.3).

On the right hand side are mainly ruderal species from a combination of wasteland habitats, for example *Conyza canadensis, Calystegia silvatica, Lactuca serriola* and *Artemisia absinthum*, and from cultivated land, for example *Fumaria officinalis* and *Urtica urens*. These are neophyte and archaeophyte species; of the thirty species with the highest scores on this axis, fifteen are archaeophytes. By contrast, the only non-native species among the 20 lowest-scoring is *Myrrhis odorata* (Tables 6.2 and 6.3); most species with a low score are species of old habitats. This is as anticipated, a result similar to the indicator species analysis using TWINSPAN, where the two major groups, 0 and 1, are an archaeophyte, human influenced group and a group with species of low nutrient requirements and semi-natural habitats respectively.

Other species on the right of the axis are species of open water or margins, such as *Potamogeton pectinatus, Oenanthe crocata* and *Sparganium emersum.* These open water and marginal species are often associated with canals, and with eutrophic water - *Potamogeton pectinatus* and *Oenanthe crocata* are both species of 'richly fertile' situations (Hill *et al.*, 1999).

The right hand side also has a number of species that are typical of rather disturbed grasslands, particularly on previously developed land, for example *Anisantha sterilis, Odontites vernus* and *Centaurium erythraea,* compared with grassland species on the left hand side, which are usually species of long-established grasslands, such as *Alchemilla* and *Euphrasia* species. There are very few species of shade on the right of the axis, with *Solanum dulcamara* and *Bryonia dioica* being species of hedges and of other shaded and unshaded situations; species of ancient woodlands are not represented on this side of the diagram.

Woody species appearing on the right of Axis 1 are those that are frequently planted in ornamental schemes, including *Acer platanoides* and *Cytisus scoparius. Sorbus aucuparia* appears slightly to the left of the centre of the axis and is both a frequently planted species and a natural component of acidic habitats. *Populus tremula*, to the right of the axis, is similar, found in woodlands and scrub on moist soils, but also planted as an ornamental.

These two groups of species suggest that the strongest trend in the tetrads is between those characterised by species of uplands, heathland and / or unimproved habitats and tetrads characterised by species of secondary and artificial habitats. This is, as expected, closely following the TWINSPAN pattern for Groups 0 and 1 because the first axis and the first dichotomy reflect the strongest trend in the data. This is illustrated in diagram 6.2, where the TWINSPAN end groups for levels 2 and 3 are shown in their positions on axes 1 and 2. The four groups at Level 2 are arranged along Axis 1, with Group 11 to the left and Group 00 to the right. There is very little overlap between the groups, and all groups are spread more or less evenly along Axis 2. This indicates that Groups 11 to 00 form a continuum with increasing human influence as the main factor, and is consistent with the summaries for the TWINSPAN groups at this level, taken with the overriding characteristics of Groups 0 and 1 (Table 5.16).

A final point about the arrangement of species in Figure 6.1 concerns the two *Calystegia* species. *Calystegia silvatica* had a score of 0.52 on Axis 1, compared to *Calystegia sepium* (not shown in Figure) at 0.27; previous work on urban flora (Hill *et al.*, 2002) had raised the question of whether *Calystegia silvatica,* as a relatively new species, had replaced *Calystegia sepium* in urban areas. The result for Axis 1 would appear to indicate that this was the case.

Figure 6.3 shows the position of the samples on the two strongest PCA axes. Samples (tetrads) are coloured according to the 10km square they represent, with the northernmost tetrads in pink and purple and the southernmost ones in red and orange. Tetrads from the rural north are mainly confined to the left hand side of Axis 1 and consequently the 'upland' or 'unimproved habitats' grouping. These tetrads include the Leek Moors, Hamps and Manifold Valleys, Churnet Valley and Dove Valley Sites of Special Scientific Interest (SSSIs). By contrast, most of the tetrads from SJ84, the Stoke-on-Trent conurbation, are found on the right side.

Tetrads from the centre of the County are mainly arranged around the centre of the axis. Nearly all tetrads from the south of the County, below Stafford, are situated to the right of Axis 1.

This north to south / left to right of the axis pattern continues, with a gradual shift until the southernmost tetrads from the Black Country conurbation are found mainly on the far right of the axis. As predicted, this pattern is very similar to that shown in Figures 5.7 and 5.10, where TWINSPAN groups are mapped. It appears to confirm that the data is split between relatively pristine, unimproved habitats and those where man has been more active. The uplands of the County are where the majority of the former habitats now survive, with the Wyre Forest, Cannock Chase. Mottey Meadows, Doley Common, Allimore Green Common and Kinver Edge SSSIs representing remnants of formerly more widespread habitats in the lowlands. Tetrads for these sites are situated to the left, or towards the centre of Axis 1, shown as red or yellow symbols in Figure 6.3 and including SO 77 U & P, SO78 K & W (Wyre), SO88 G (Kinver), SJ91T, X, Y, Z, SJ92 V, SK01 C, D, E, G, H, I, L, M (Chase), SJ82A (Doley), SJ81P (Allimore) and SJ81 G & L (Mottey).

Tetrads from SK06 and SK16 show strong clustering when plotted on Axes 1 and 2. They would therefore appear to be rather uniform squares in terms of species composition. SK06 and SK16 comprise mainly moorland, dominated by *Calluna vulgaris,* with some enclosed pasture. There are few hedges, woodlands or major roads and only small settlements. Most of the moorland area is designated as a Site of Special Scientific Interest (SSSI), but the main interest for which the SSSI was designated is the assemblage of breeding birds such as golden plover (*Pluvialis apricaria*), (English Nature, 1988). The vegetation, although of exceptional quality in places, is like most moorlands, not very diverse.

Table 6.1 - Twenty species with lowest score on Axis 1

Species	Score on axis 1	Origin	N*
Oxalis acetosella	-0.5819	Native	4
Blechnum spicant	-0.548	Native	3
Stellaria uliginosa	-0.5449	Native	5
Vaccinium myrtillus	-0.5404	Native	2
Succisa pratensis	-0.5389	Native	2
Chrysosplenum oppositifolium	-0.5225	Native	5
Myrrhis odorata	-0.52	Neophyte	7
Valeriana officinalis	-0.5194	Native	5
Luzula sylvatica	-0.5154	Native	4
Potentilla erecta	-0.5035	Native	2
Lysimachia nemorum	-0.4893	Native	5
Lathyrus linifolius	-0.4874	Native	3
Alchemilla glabra	-0.487	Native	4
Campanula rotundifolia	-0.4774	Native	2
Ranunculus flammula	-0.4749	Native	3
Cirsium palustre	-0.4742	Native	4
Oreopteris limbosperma	-0.4731	Native	3
Briza media	-0.4681	Native	3
Athyrium filix-femina	-0.4631	Native	6
Alchemilla xanthochlora	-0.463	Native	4
AVERAGE			3.8

Table 6.2 - Twenty species with highest score on Axis 1

Name	Score on axis 1	Origin	N*
Hordeum murinum	0.6853	Archaeophyte	6
Lactuca serriola	0.6799	Archaeophyte	6
Armoracia rusticana	0.6245	Archaeophyte	7
Malva sylvestris	0.6242	Archaeophyte	7
Reseda luteola	0.6094	Archaeophyte	6
Artemisia absinthum	0.609	Archaeophyte	9
Papaver rhoeas	0.606	Archaeophyte	6
Conyza canadensis	0.5988	Neophyte	6
Silene latifolia	0.5939	Archaeophyte	6
Fumaria officinalis	0.5855	Neophyte	6
Convolvulus arvensis	0.5713	Native	6
Papaver dubium	0.5704	Archaeophyte	5
Euphorbia peplus	0.5703	Archaeophyte	6
Senecio squalidus	0.5691	Neophyte	7
Euphorbia helioscopia	0.5663	Archaeophyte	6
Aethusa cynapium	0.556	Native	6
Geranium molle	0.5508	Native	5
Crepis vesicaria	0.5473	Neophyte	7
Linaria purpurea	0.5356	Neophyte	6
Melilotus officinalis	0.531	Neophyte	5
AVERAGE			**6**

*Nitrogen requirement as given in 'Ellenberg's indicator values for British plants' (Hill *et al.*, 1999)

KEY			
1	Species of extremely infertile sites	6	Between 5 & 7
2	Between 1 & 3	7	Plant of richly fertile places
3	Species of +/- infertile sites	8	Between 7 & 9
4	Between 3 & 5	9	Species of extremely rich situations
5	Species of sites of intermediate fertility		

Figure 6.1 - Scatter diagram of species and their positions on PCA Axes 1 & 2

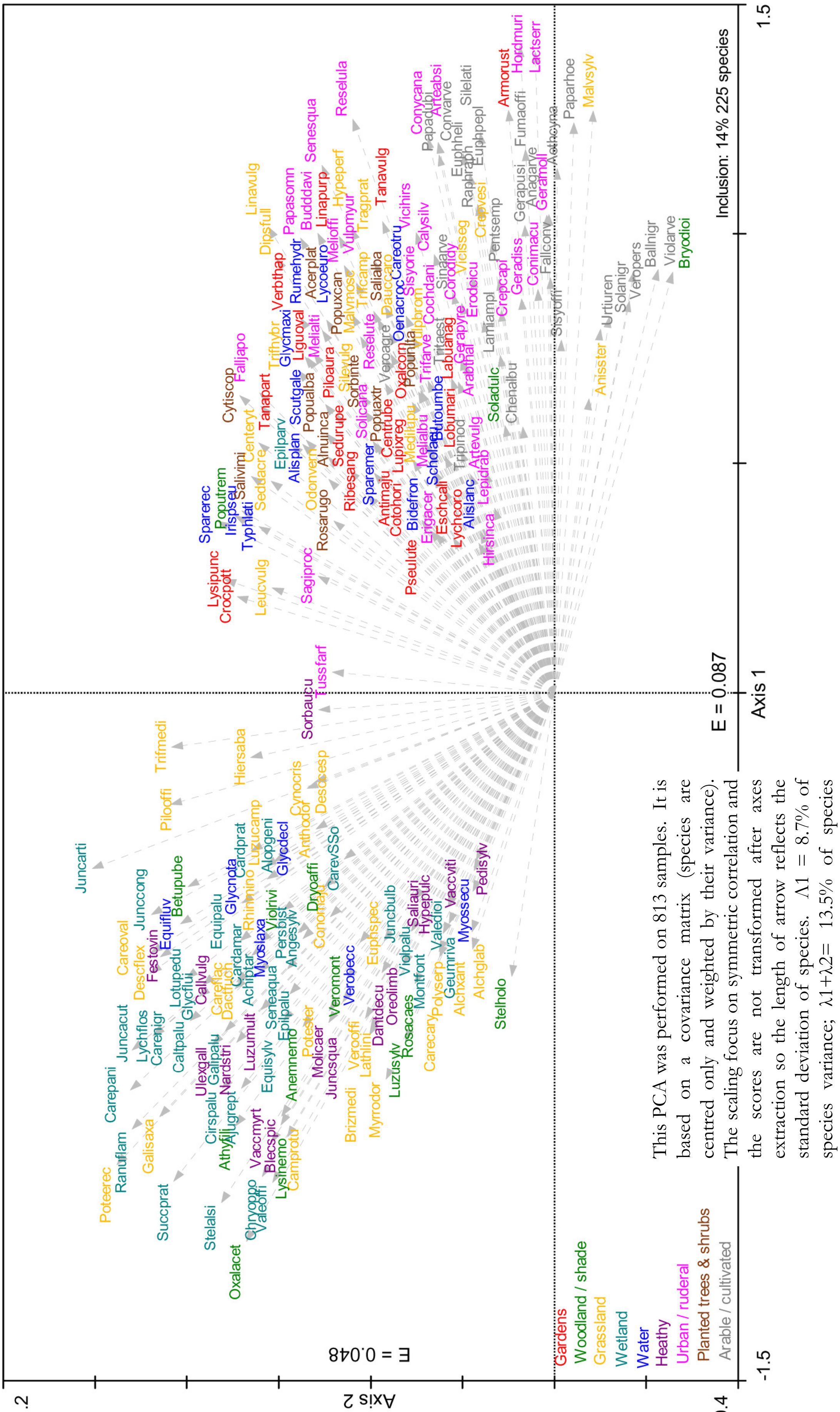
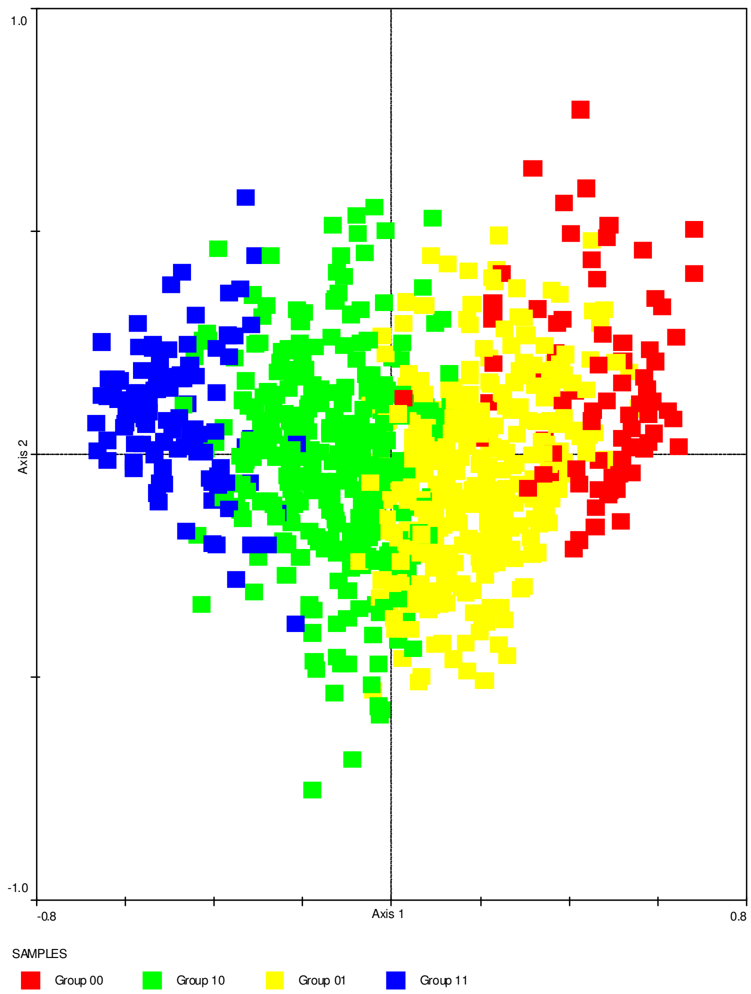
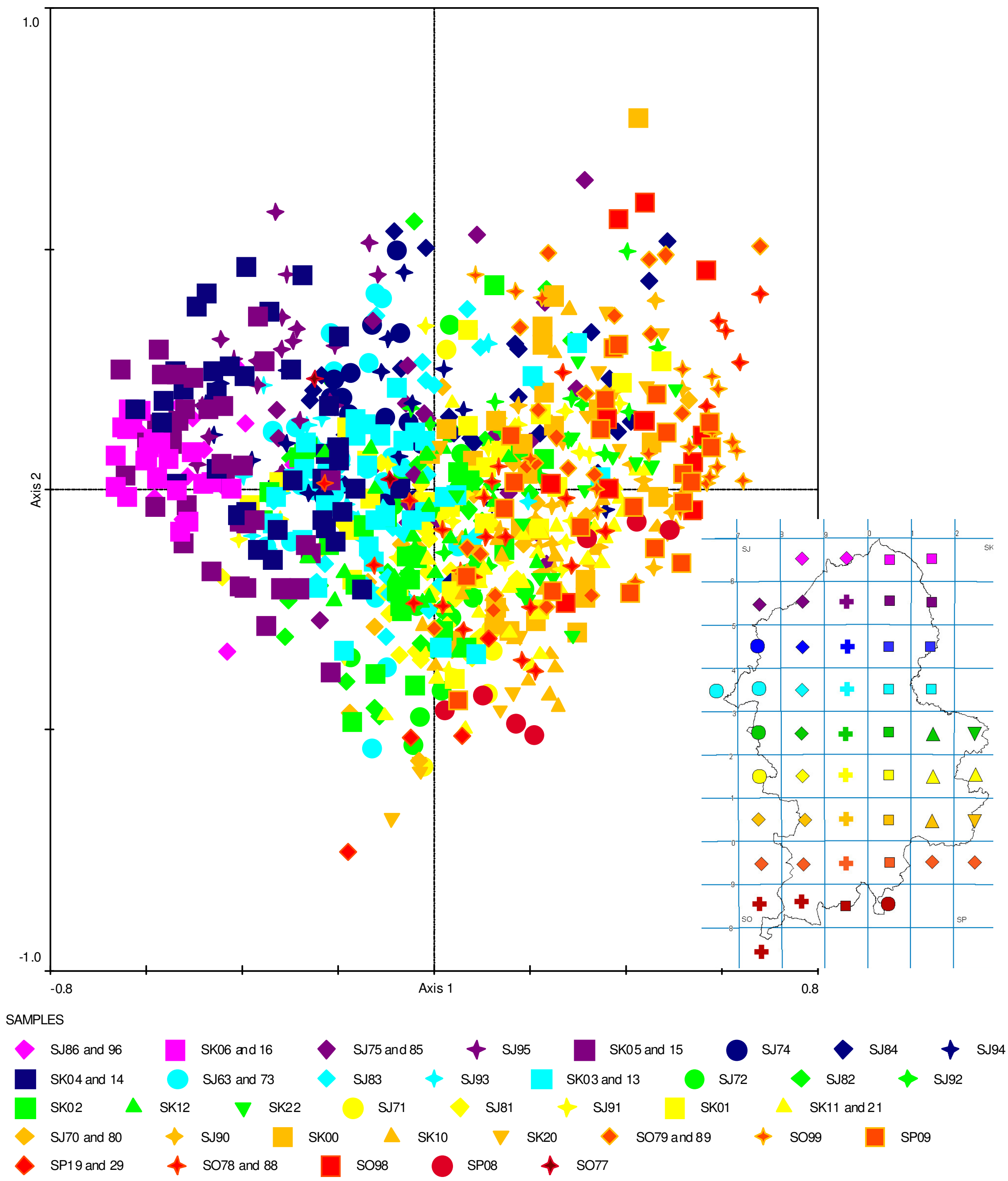


Figure 6.2 - TWINSPAN Level 2 groups shown on PCA Axes 1 & 2



**Square dots represent individual tetrads*

Figure 6.3 –Tetrads and their position on PCA Axes 1 and 2*



**Inset – key to locations in County*

6.1.2 Axis 2

The species are asymmetrically divided on Axis 2, with most species being situated towards the top of the axis (Figure 6.4, Tables 6.3 and 6.4). This suggests an actual difference in species density with stands situated at the top of Axis 2 being relatively species-rich.

Species at the top of Axis 2 are all in the top left of the scatter diagram, and include mainly species of wetlands such as *Carex panicea, Ranunculus flammula, Juncus acutiflorus* and *Juncus articulatus*. There are also species of grasslands, including *Potentilla erecta, Carex ovalis, Galium saxatile* and *Deschampsia flexuosa*. To the centre left of Figure 6.1a, there are wetland and grassland species as before, but also species of heathland, such as *Nardus stricta, Vaccinium myrtillus, Blechnum spicant* and *Calluna vulgaris* and woodland such as *Lysimachia nemorum, Anemone nemorosa* and *Oxalis acetosella*. Of these most have an Ellenberg value of at least 6 for moisture requirement (Hill *et al.*, 1999).

Species to the centre right of the diagram include species of open water or wetland, such as *Iris pseudacorus, Sparganium erectum* and *Typha latifolia* and species of disturbed situations, such as *Fallopia japonica*. The latter often include species of somewhat drier situations than those on the left side of the diagram. It is likely that the situation with respect to water requirement is complex, because Axis 1 as a biogeographical axis to some extent also has to do with water, where species with a high score on Axis 1 tend to be species of dry climates, while those with a low score are those from wetter climates. However, Axis 2 appears to include a large proportion of species with a moderate to high water requirement; tetrads to the top right of the diagram are apparently from urban areas with open water or wetland.

Both urban and rural parts of the top of the axis have species of dry substrates too, for example *Centaurium erythraea, Cytisus scoparius,* and *Tanacetum parthenium* on the urban side and *Festuca ovina, Pilosella officinarum* and *Trifolium medium* on the other. It is probable that the tetrads at the top of the axis have both wetland and dry habitats, and that these tetrads are consequently the most species rich in the County.

Table 6.3 - Twenty species with highest score on Axis 2

Species	Score on axis 2	Moisture*
Juncus articulatus	0.5146	9
Carex panicea	0.4791	8
Potentilla erecta	0.4669	7
Ranunculus flammula	0.4594	9
Juncus acutiflorus	0.4509	8
Carex ovalis	0.4478	7
Carex nigra	0.4399	8
Lychnis flos-cuculi	0.4352	9
Juncus conglomeratus	0.4327	7
Deschampsia flexuosa	0.4286	5
Equisetum fluviatile	0.4286	10
Lotus pedunculatus	0.4238	8
Pilosella officinarum	0.4234	4
Succisa pratensis	0.4194	7
Galium saxatile	0.4187	6
Festuca ovina	0.4182	5
Deschampsia cespitosa	0.4171	6
Cardamine pratensis	0.4069	8
Trifolium medium	0.406	4
Glyceria fluitans	0.4029	10
Average		**7**

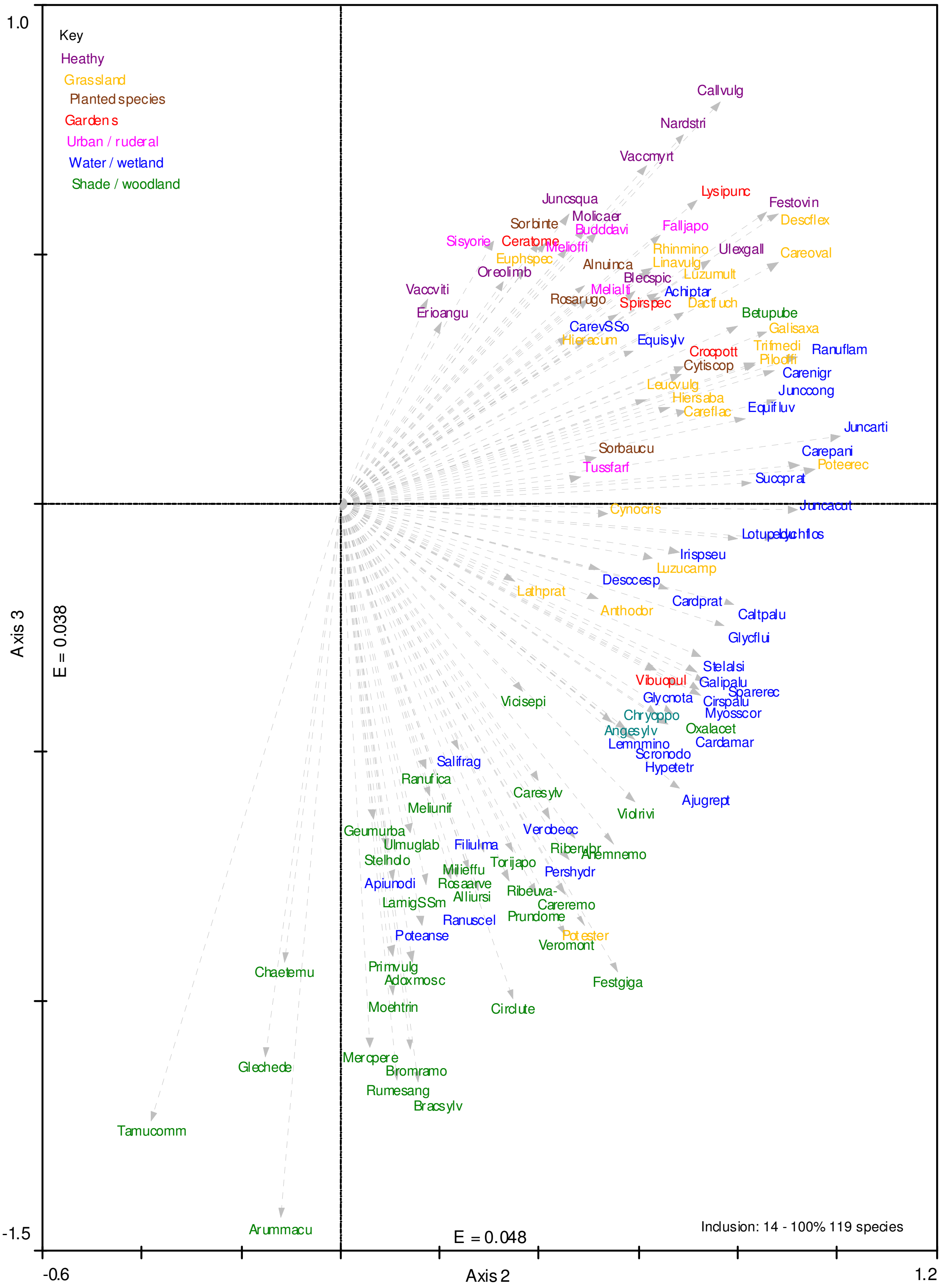
Table 6.4 - Twenty species with lowest score on Axis 2

Species	Score on axis 2	Moisture*
Tamus communis	-0.1855	5
Bryonia dioica	-0.1352	5
Coronopus squamatus	-0.1332	5
Rubus ulmifolius	-0.1258	N/a
Viola arvensis	-0.1116	4
Veronica persica	-0.097	5
Glechoma hederacea	-0.0887	6
Ballota nigra	-0.0864	4
Rubus ulmifolius x *vestitus*	-0.0856	N/a
Lamium album	-0.0794	5
Solanum physalifolium	-0.0778	N/a
Hornungia petraea	-0.0747	2
Vicia faba	-0.0721	4
Geranium rubescens	-0.072	N/a
Symphytum asperum	-0.0716	N/a
Cirsium eriophorum	-0.0697	4
Phacelia tanacetifolia	-0.0689	N/a
Bromus secalinus	-0.0685	N/a
Myosurus minimus	-0.0675	7
Silene nutans	-0.0652	3
Average		**4.5**

**Moisture requirement as given in 'Ellenberg's indicator values for British plants' (Hill et al., 1999). 4*

Key			
1	Species of extremely dry sites	6	Between 5 & 7
2	Between 1 & 3	7	Plant of damp places
3	Species of dry sites	8	Between 7 & 9
4	Between 3 & 5	9	Species of wet situations
5	Species of moist sites	10	Species of shallow water

Figure 6.4 - Species and their positions on Axes 2 and 3



This PCA was performed on 813 samples. It is based on a covariance matrix (species are centred only and weighted by their variance). The scaling focus on symmetric correlation and the scores are not transformed after axes extraction so the length of arrow reflects the standard deviation of species. $\lambda 1+\lambda 2$ =13.5% of species variance; $\lambda 1+\lambda 2+\lambda 3$= 17.3% of species variance

There are few species with a low score on Axis 2 in Figure 6.4. They are all to the left of the diagram, and include *Bryonia dioica, Viola arvensis, Veronica persica, Urtica urens* and *Ballota nigra*. With the exception of *Bryonia dioica*, a species of disturbed, shady conditions thought to be confined to the lowland in Britain (Preston *et al.*, 2002), these are all species of arable situations. None of these species is particularly associated with urban areas, and are not listed as indicators of high urbanity by Hill *et al.,* (2002) in their study of bioindicators and human impact. *Anisantha sterilis* is also situated on this part of the axis and may be found in arable sites and on roadsides and waste ground. Arable situations are nearly always dry, or at least free-draining, and the species on this part of the axis are indicators of dry to moist sites, with the exception of *Glechoma hederacea* and *Myosurus minimus*. This is in contrast to most species at the top of the axis (Tables 6.3 and 6.4 show the Ellenberg water requirements of species at the extreme ends of both axes (Hill *et al.*, 1999)).

There appears to be a paucity of species in the lower part of the axis consistent with arable areas of the County that lack semi-natural habitats. This confirms the axis as being one mainly to do with species-richness.

Figures 6.2 and 6.5 show TWINSPAN groups on Axes 1 and 2. As mentioned in Section 6.1.1, the groups at Level 2 do not show much response on Axis 2, however TWINSPAN Level 3 groups tend to separate along Axis 2. Groups 110 and 101 are found in the upper left quarter, groups 010, 001 and 000 in the upper right quarter, groups 111 and 100 in the lower left and group 011 in the lower right quarter, although there is considerable overlap. These can be summarised as in Figure 6.6, and closely correspond to the summary of TWINSPAN analysis for all groups at this level.

Figure 6.5 - TWINSPAN Level 3 groups shown on PCA Axes 1 & 2

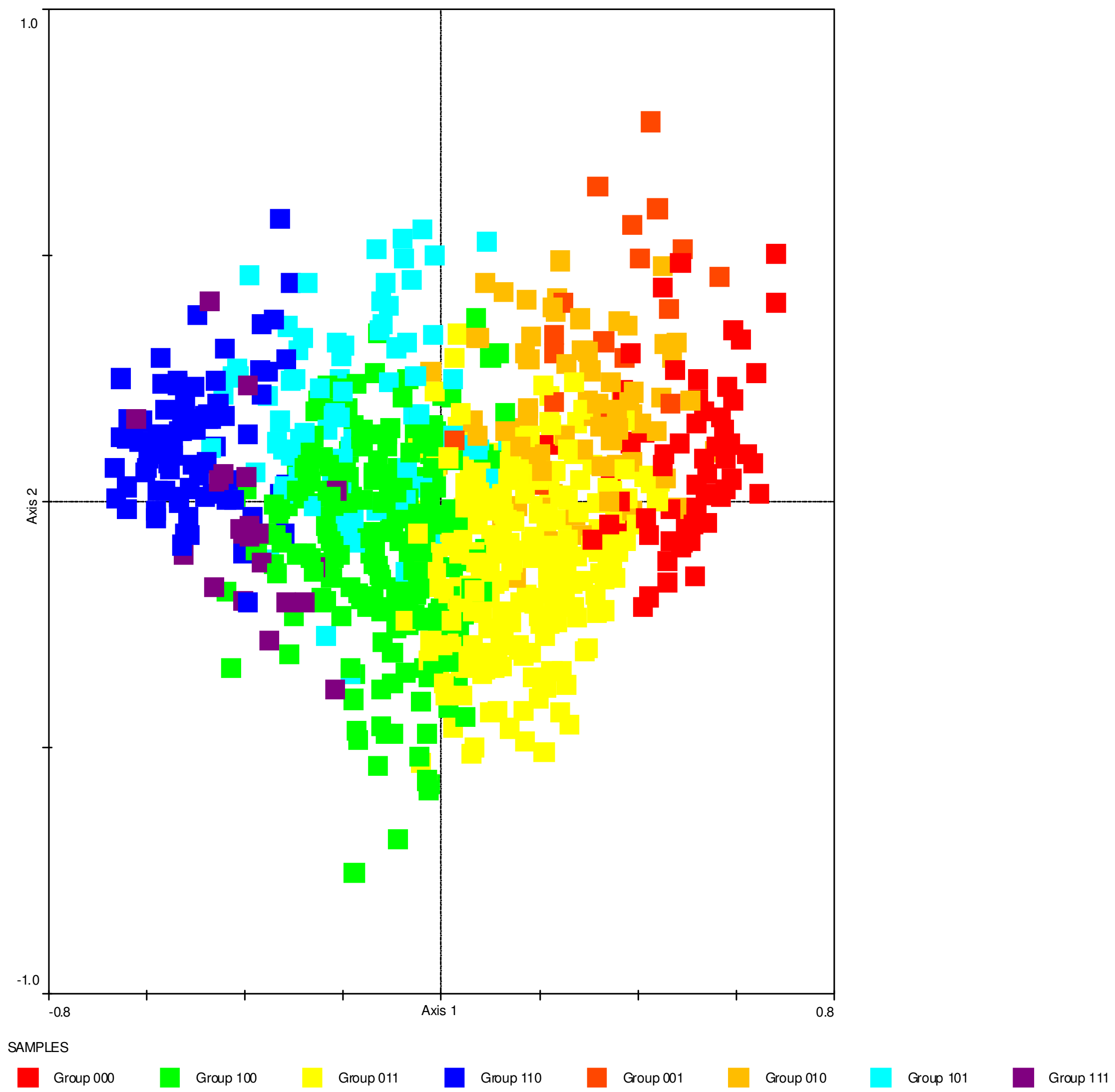
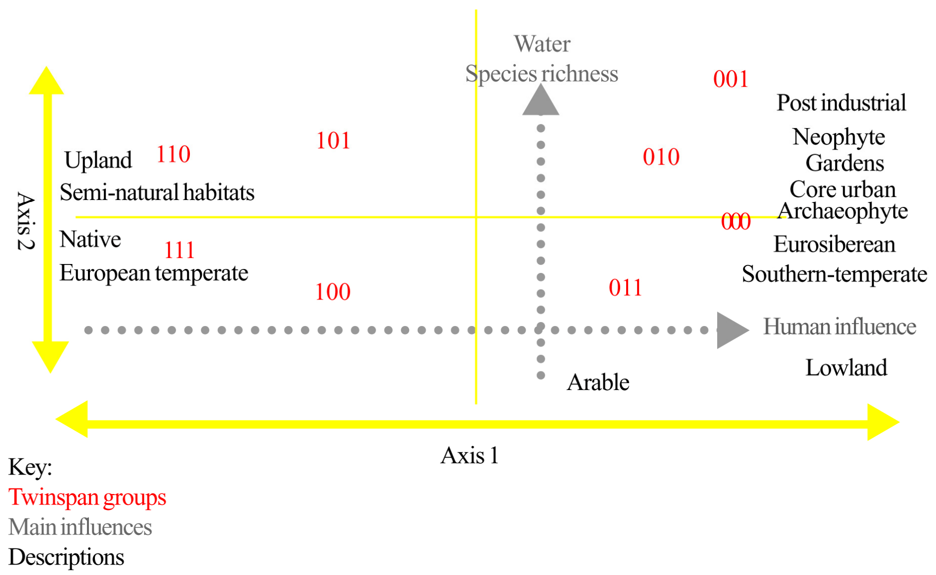


Figure 6.6 – Summary of Axes 1 and 2

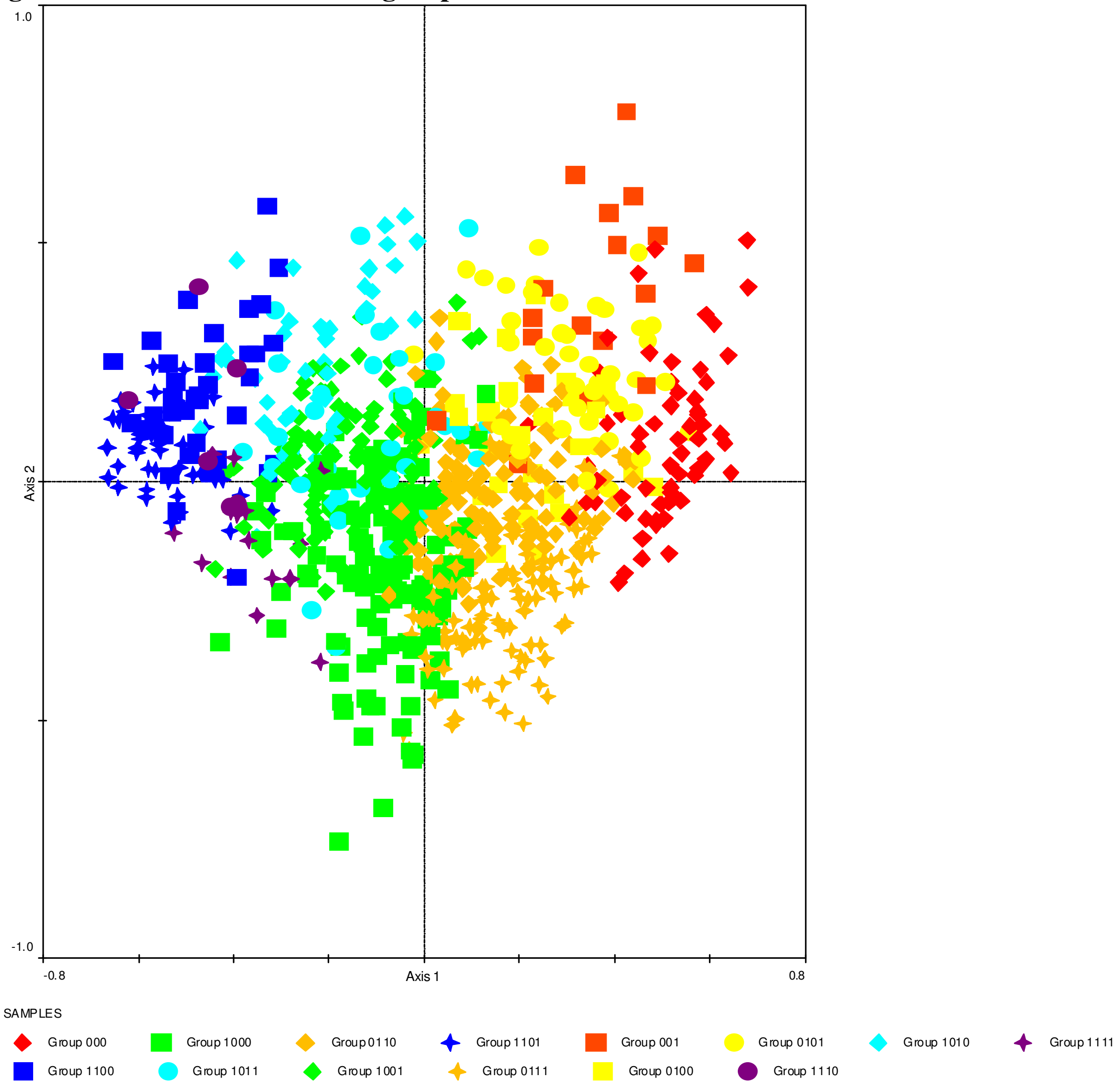


The TWINSPAN classification at the fourth level also partly separates along Axis 2, as shown in Figure 6.7. Group 0111 appears to have less wetland influence than Group 0110 and Group 1000 seems both drier and more human- influenced than Group 1001. These are again consistent with the summary of TWINSPAN results (Table 5.16), although the underlying factor is more likely to be habitat- and species- richness than simply wetlands. Group 1100 compared to Group 1101 appears to be more species-rich; the TWINSPAN results suggest that this division is related to ancient woodland and moorland. The remaining Groups overlap, so cannot be separated on the basis of either axis.

The tetrads corresponding to the lower part of Axis 2 are from disparate parts of the County (Figure 6.3), and include a number of incomplete tetrads, including four from SP08. However there are also complete tetrads, including some from near Blithfield, southeast of Lichfield and the plateau between Dove Dale and the Manifold Valley. No obvious physical characteristics link these areas, except that apart from SP08 most squares include intensively farmed areas.

Tetrads from the top of Axis 2 are similarly from unconnected areas, including SJ95A, SJ82A, SK85K, SJ80I and SO98E and SO98I. All of these have a combination of habitats, including wetland, with those in the upper right quadrant of the diagram from post-industrial areas with a combination of wet and dry substrates, such as Saltwells (Dudley), Chasewater (Lichfield) and the Westport and Chatterley area of Stoke. To the left of the diagram are tetrads from Deep Hayes (a country park with exceptional habitats), and from Stanton, which also has outstanding habitats.

Figure 6.7 - TWINSPAN level 4 groups shown on PCA Axes 1 & 2



6.1.3 Axis 3

The scatter diagram of species for Axes 2 and 3 is shown in Figure 6.4, indicative colour coding has been used to show habitat preferences for clarity. Species lists for the extreme ends of Axis 3 are given in tables 6.5 and 6.6.

Species at the top of Axis 3 are mainly species of heathland including *Calluna vulgaris, Nardus stricta, Vaccinium myrtillus* and *Eriophorum angustifolium*. There are also species of grassland such as *Rhinanthus minor* and *Euphrasia* species, and species of ruderal conditions such as *Vulpia myuros* and *Sisymbrium orientale*, as well as species that are frequently planted (*Alnus incarna*) and species that frequently escape from gardens such as *Cerastium tomentosum*. Altogether, these are mainly found in open situations, preferring well-lit conditions (Table 6.5), although some of the species of heathland will persist in shade in heathy woods, including *Calluna vulgaris* and *Vaccinium myrtillus*.

Species at the lower end of the diagram (low scores on Axis 3) are species of shade including *Arum maculatum, Glechoma hederacea, Rumex sanguineus, Mercurialis perennis* and *Tamus communis*. These are all species of shaded conditions in hedges, scrub or woodland, with an average Ellenberg score of 5 for light requirement (semi-shade plants) (Hill *et al.*, 1999) (Table 6.6). Species on this part of the diagram with a requirement for lighter conditions (Ellenberg score of 7+) include *Filipendula ulmaria, Potentilla anserina* and *Ranunculus sceleratus*, which are species of wet conditions.

TWINSPAN Groups 00 and 11 are mainly confined to the top of Axis 3 (Figure 6.8); this is expected for Group 00 because this is the most human-influenced group, where woodland habitats are scarce. Group 11 however, as part of Group 1 appeared to have strong woodland influences, and it might have been expected to be more evenly spread along this axis, as indeed are Groups 01 and 10.

Table 6.5 - Twenty species with highest score on Axis 3

Species	Score on axis 2	Light*
Calluna vulgaris	0.4225	7
Nardus stricta	0.4205	7
Vaccinium myrtillus	0.3742	6
Juncus squarrosus	0.373	7
Vaccinium vitis-idaea	0.3714	6
Oreopteris limbosperma	0.3562	6
Eriophorum angustifolium	0.3411	8
Euphrasia species	0.3328	8
Sisymbrium orientale	0.3324	7
Molinia caerulea	0.3312	7
Empetrum nigrum	0.3249	7
Cerastium tomentosum	0.317	8
Lysimachia punctata	0.3086	6
Eriophorum vaginatum	0.3078	8
Sorbus intermedia	0.3076	6
Erica tetralix	0.3016	8
Lupinus x *regalis*	0.2951	N/a
Melilotus officinalis	0.292	8
Hirschfeldia incarna	0.2857	8
Festuca ovina	0.2856	7
Average		**7**

**Light requirement as given in 'Ellenberg's indicator values for British plants' (Hill et al., 1999)*

Table 6.6 - Twenty species with lowest score on Axis 3

Species	Score on axis 2	Light*
Arum maculatum	-0.7207	4
Glechoma hederacea	-0.6505	6
Rumex sanguineus	-0.6129	5
Tamus communis	-0.6038	6
Mercurialis perennis	-0.5959	3
Brachypodium sylvaticum	-0.5679	6
Bromopsis ramosa	-0.5374	4
Circaea lutetiana	-0.4846	4
Moehringia trinervia	-0.4823	4
Filipendula ulmaria	-0.4723	7
Adoxa moschatellina	-0.4667	4
Geum urbanum	-0.4624	4
Festuca gigantea	-0.4582	5
Chaerophyllum temulum	-0.4564	6
Ulmus glabra	-0.4562	4
Primula vulgaris	-0.4498	6
Rosa arvensis	-0.4439	6
Potentilla anserina	-0.4385	8
Veronica montana	-0.4314	4
Lamiastrum galeobdolon ssp *montanum*	-0.4313	4
Average		**5**

**Light requirement as given in 'Ellenberg's indicator values for British plants' (Hill et al., 1999).*

KEY			
3	Species of shade	7	Plant of well-lit places, but may also occur in partial shade
4	Between 3 & 5	8	Light loving species
5	Species of semi-shade	9	Species of full light conditions
6	Between 5 & 7		

TWINSPAN groups at Level 3 do not appear to show much response on Axis 3 (Figure 6.9); this is as expected because shade or woodland is not indicated as a determining factor for any groups at this level (Table 5.16). At the next level, however, three pairs of groups appear to be influenced (Figure 6.10). These are the shaded groups 0101, 1010 and 1100 and their less-shaded counterparts 0100, 1011 and 1101 respectively. Again, this appears to confirm the exploration of the TWINSPAN results, particularly with respect to Groups 1010 and 1100, which are thought to be associated with ancient woodland.

Figure 6.11 shows the tetrad locations on Axes 2 and 3, where the centre of the County tetrads (turquoise, yellow and green) are towards the lower end of Axis 3, while the north and south tetrads are mainly towards the top of the axis. SJ74, SK04 and SK14 (dark blue circles and squares) are divided between the top and bottom, indicating that they have both shaded and open tetrads.

Figure 6.8 - TWINSPAN Level 2 groups shown on PCA Axes 2 and 3

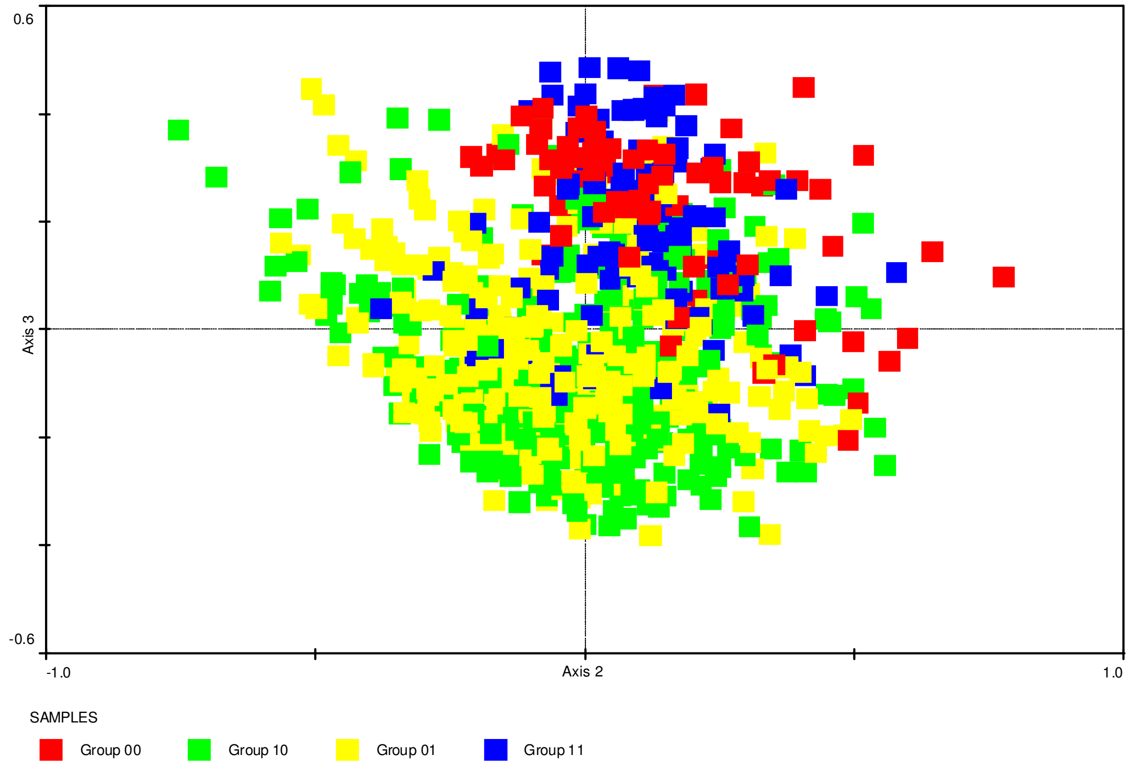


Figure 6.9 - TWINSPAN Level 3 groups shown on PCA Axes 2 and 3

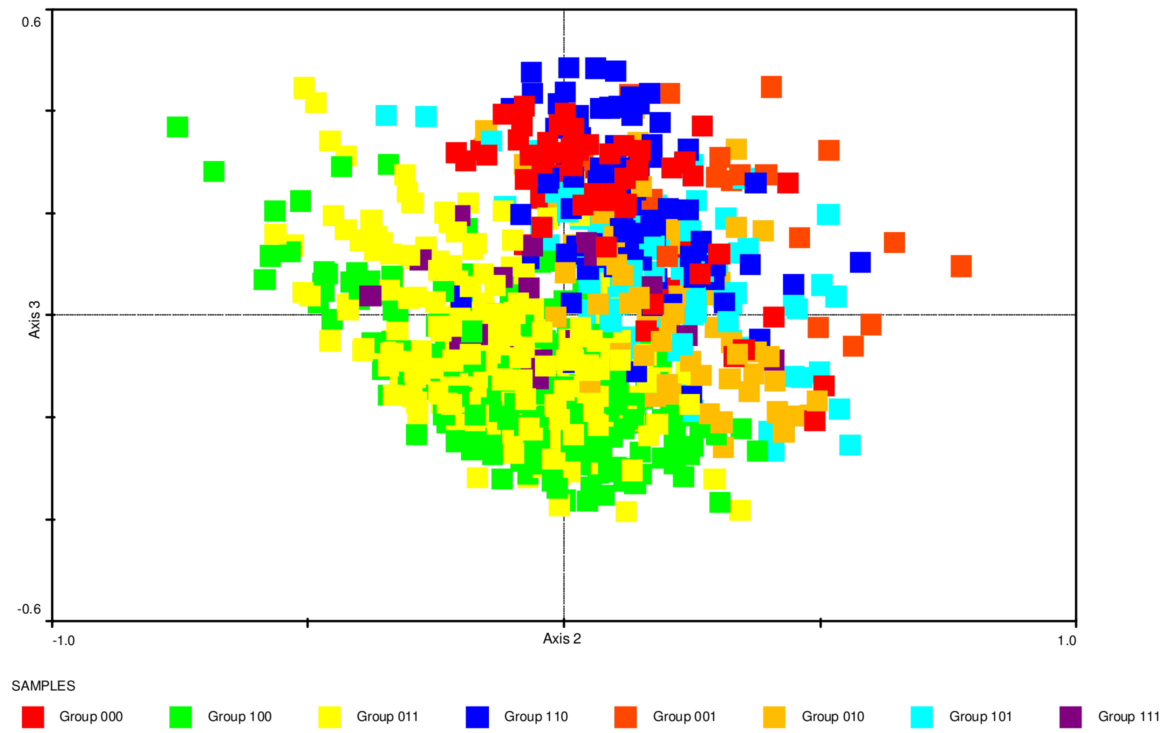


Figure 6.10 - TWINSPAN level 4 groups shown on PCA Axes 2 and 3

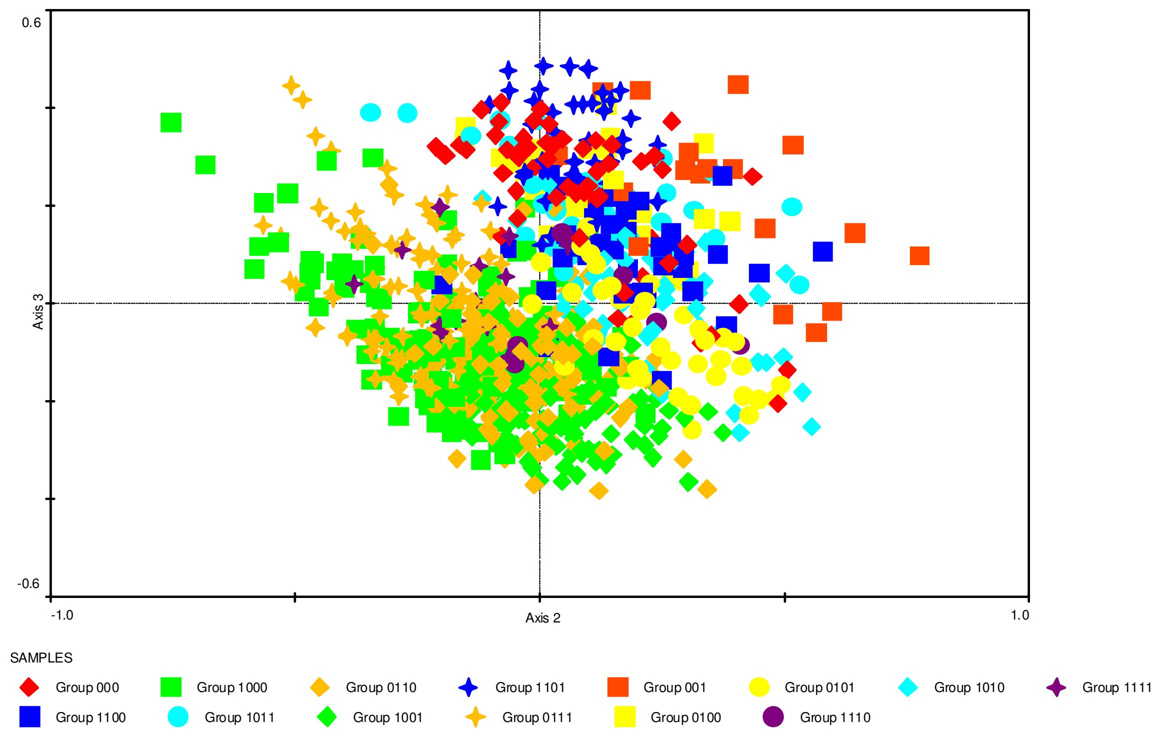
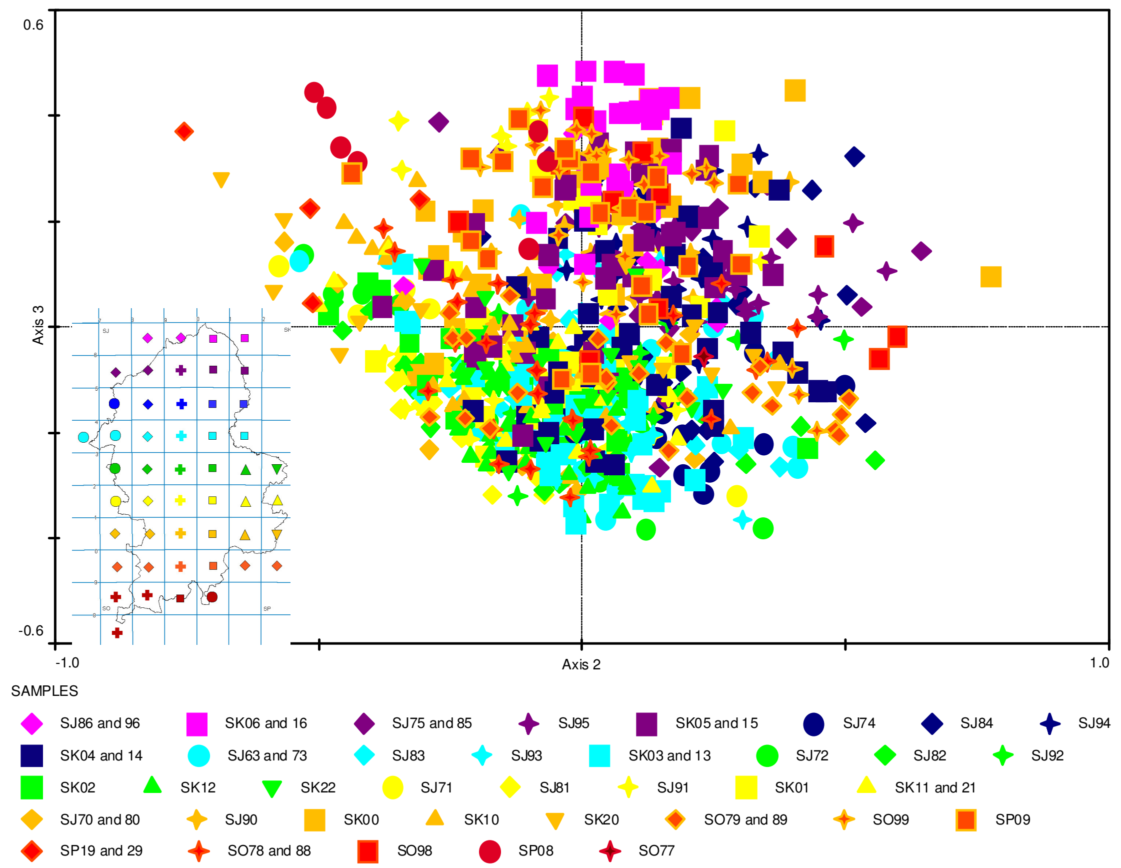


Figure 6.11 – Tetrads and their position on PCA Axes 2 and 3



6.1.4 Axis 4

Figure 6.12 shows *Helianthemum nummularium, Scabiosa columbaria, Cystopteris fragilis, Koeleria macrantha, Galium sterneri*, *Saxifraga tridactylites, Ribes alpinum* and *Arabis hirsuta* at the top of Axis 4. These are all species with an Ellenberg value of 7 (species of weakly acidic to weakly basic conditions) or 8 (between 7 and indicator of basic reaction, 9) for pH (Hill *et al.*, 1999). Other species at the top of Axis 4 are: *Thymus polytrichus* and *Saxifraga granulata* (Ellenberg scores of 6 for pH requirement). These collectively indicate basic conditions.

Species in the lower left of the diagram are of mainly mixed pH requirement, although there are more species with a value of 6 or less than at the top of the axis, including *Galium palustre* and *Quercus robur*.

On the lower right hand side of the diagram are species of base-poor conditions, such as *Carex ovalis, Molinia caerulea, Juncus bulbosus* and *Erica tetralix*.

Where the TWINSPAN groups are mapped onto Axis 4 (Figure 6.13), Groups 001 and 0100 are arranged mainly in the lower right of the diagram and are apparently associated with acidic conditions. These groups are described as acidic in the TWINSPAN discussion, so this would be expected.

Group 000, which is thought to have some base-enrichment, does have some tetrads towards the top of Axis 4, confirming this view. The 'limestone' groups 1110 and 1111 are both towards the top of axis 4 as anticipated. Most Group 1111 tetrads are at the top of Axis 4; this is the typical limestone group, whereas Group 1110, the group with complex habitats including base-rich ones is found slightly lower on the axis.

The centre right of the diagram lacks species that are explained well by the two axes. This part of the diagram contains a cluster of most of the Group 000 tetrads and therefore possibly contains a range of overlying artificial substrates where base status of the underlying soils could be expected to be an unreliable indicator of the vegetation

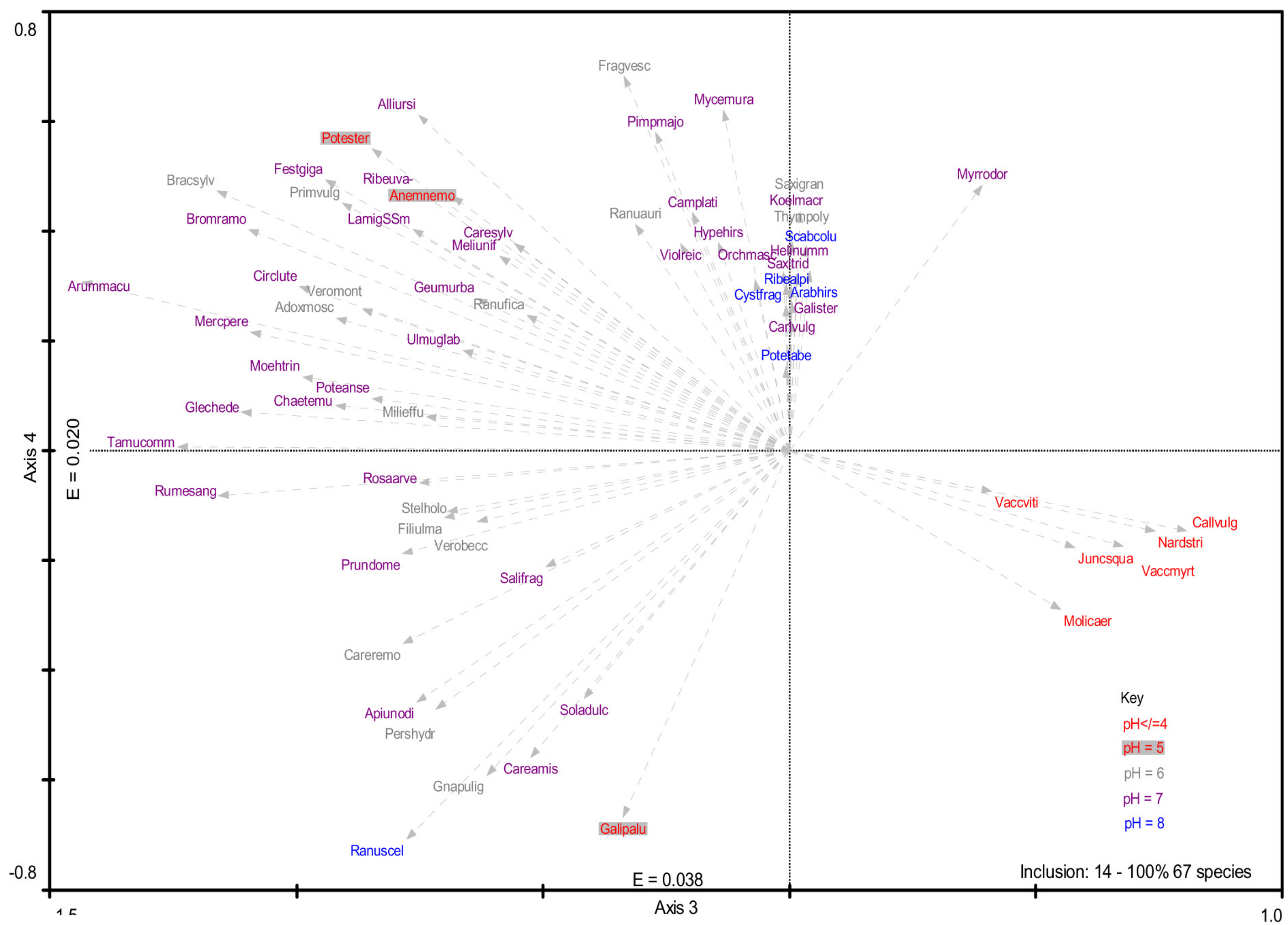
Figure 6.14 shows the location of tetrads on Axes 3 and 4. In the lower right corner are tetrads from Cannock Chase and surrounding areas, all of which tend to have sandy, acidic soils. A large number of tetrads are found in the lower left corner; these are presumably those with acidic and shaded conditions. As most of the County is on base-poor soils, woodlands tend to be heathy or at least slightly base-poor in type, with base-rich woodlands and their indicators, such as *Paris quadrifolia* and *Ranunculus auricomus* rare.

As expected, a number of tetrads on the top of Axis 4 are from the limestone areas of the northeast of the County. Other tetrads are from the Sedgley, Dudley and Walsall areas, which also have limestone geology. Tetrads from the top left corner are from the Limestone areas, from the Churnet Valley where some of the complex woodland is on base-rich soils, and from the Marchington area, which has base-rich woodland.

6.1.5 Summary

Unconstrained analysis using CANOCO suggests that four axes of variation: human influence, species-richness, shade and base status, can be used to describe the distribution of species in Staffordshire. These largely confirm the findings of the Indicator Species Analysis, which grouped samples on a combination of these factors, although habitat-richness, particularly the presence of wetlands, was more apparent than species-richness *per se*.

Figure 6.12 - Species and their positions on Axes 3 and 4*



This PCA was performed on 813 samples. It is based on a covariance matrix (species are centred only and weighted by their variance). The scaling focus on symmetric correlation and the scores are not transformed after axes extraction so the length of arrow reflects the standard deviation of species. $\Lambda1+\lambda2+\lambda3 = 17.3\%$ of species variance; $\lambda1+\lambda2+\lambda3+\lambda4= 19.3\%$ of species variance

* *pH requirement as given in 'Ellenberg's indicator values for British plants' (Hill et al., 1999)*

Figure 6.13 - TWINSPAN level 4 groups shown on PCA Axes 3 and 4

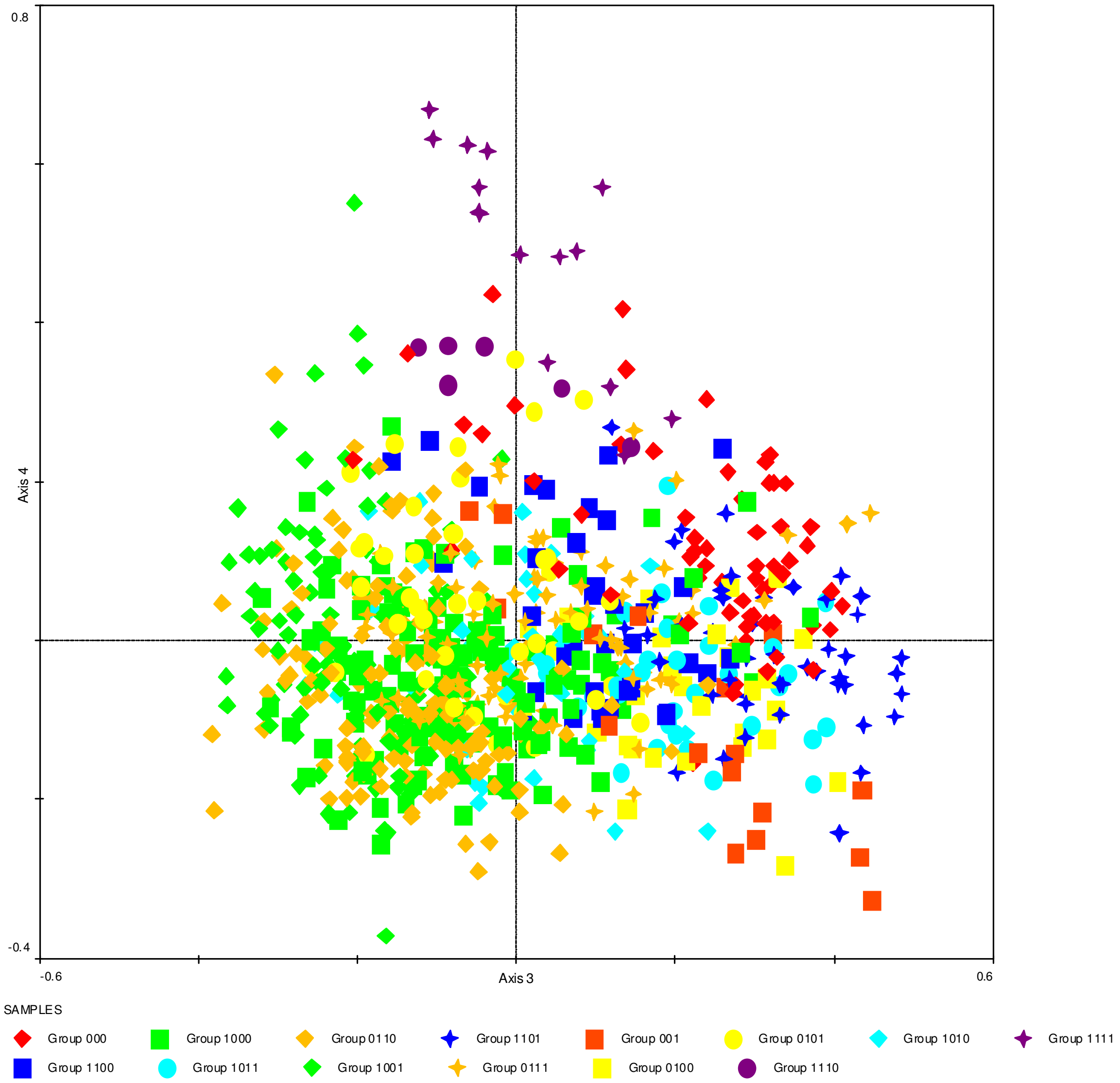
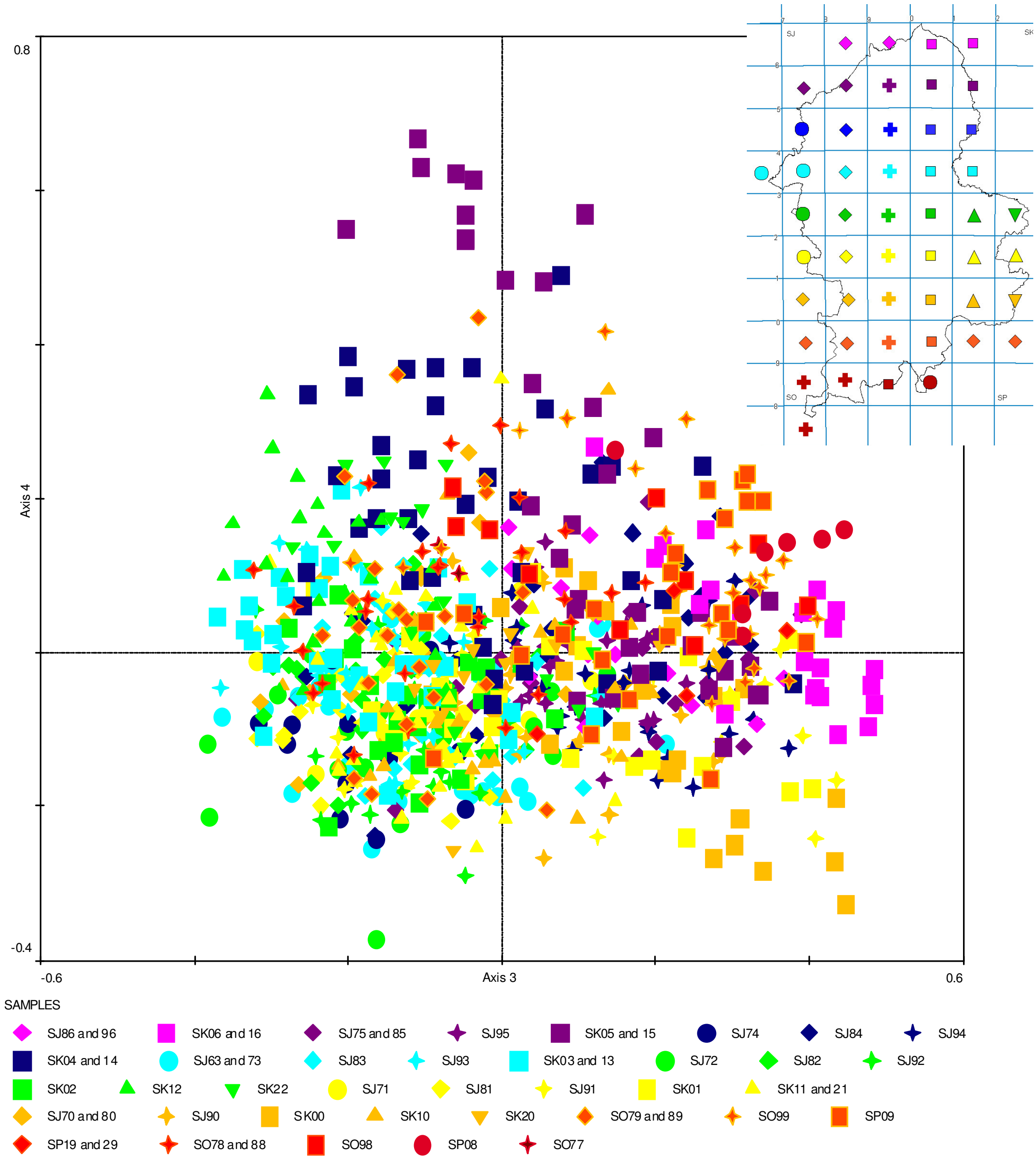


Figure 6.14 - Tetrads and their position on PCA Axes 3 and 4*



**Inset – key to tetrad locations*

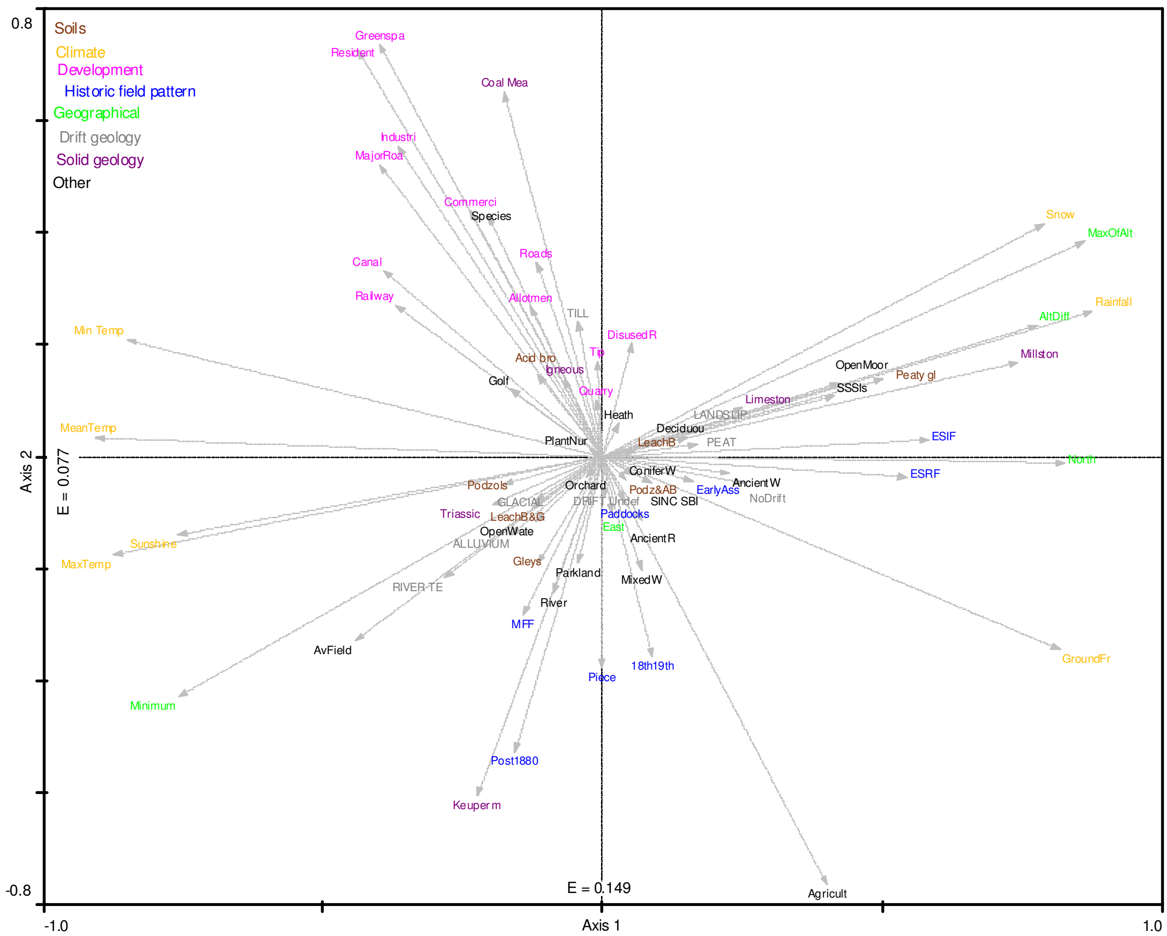
6.2 Initial analysis of environmental variables

Analysis of the variables only using DCA was carried out. The largest gradient was 1.998, indicating that the responses of variables were linear rather than unimodal. Therefore, Principal Components Analysis was carried out. As recommended (ter Braak and Šmilauer, 2002), the data were centred and standardised by species because the 'species' in this case are the variables, measured using a range of different units, such as metres height, area or degrees centigrade. Figure 6.15 shows the result of this analysis. Appendix B shows the variables and their abbreviations.

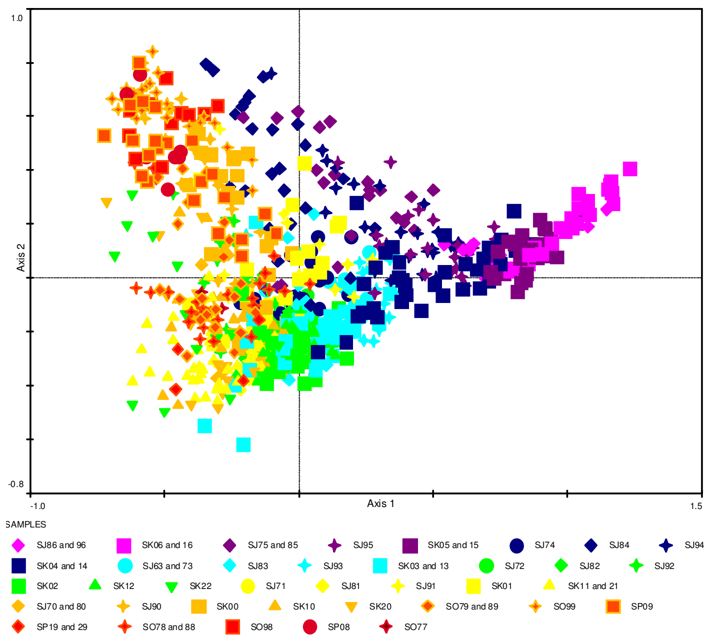
The left side of the diagram is associated with warmer temperatures and low altitude, this is the south part of the County. On the right side is the north of the County, with a harsher climate and characterised by Millstone Grit and Limestone geology and the largest variation in altitudes within tetrads. This north / south gradient can be seen in the inset diagram.

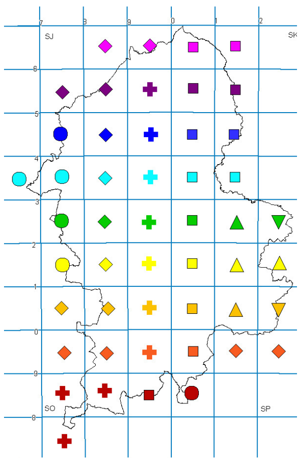
Variables that are not arranged north – south along Axis 1 separate on Axis 2 into development and agriculture. They are clearly focussed on human activity, with vectors associated with urban areas increasing upwards and those associated with lowland agriculture downwards. Coal measures and igneous geology are strongly associated with urban development, as is number of species per tetrad. The lower part of the diagram includes many of the historic field types that may indicate a history of agriculture. Other indications of agriculture in the lower part of the diagram include large field sizes and drift geology including River Terrace and Alluvium, with Keuper Marl geology, implying that more-intensive agriculture may be possible in these areas. The older field types are more closely associated with the north of the County.

Figure 6.15 - Variables Only PCA centred and standardized by variables (species)*



This PCA was performed on 813 samples. It is based on a correlation matrix ('species' are centred and standardised). The scaling focuses on inter-species correlations and the scores are standardised after axes extraction so the length of arrow reflects is a measure of fit with the ordination diagram. $\lambda1$ = 14.9% of (species) variables variance; $\lambda1+\lambda2$ = 22.6% of variables variance





**insets: Location of tetrads on Axes 1 & 2; location of tetrads in County.*

The locations of tetrads on these axes are shown in Figure 6.15 with a strong south to north / left to right influence seen on Axis 1, corresponding to the warmer temperatures and lower altitudes in the south, and colder climate and higher and more variable altitude in the north.

Tetrads for Cannock Chase, Kinver Edge and Wyre Forest occupy similar positions on Axis 1 to their locations on Axis 1 in the PCA analysis of species described in Section 6.1. This shows that the majority of the environmental characteristics of these tetrads are similar to the upland areas, although climate and geology are clearly different. Millstone Grit is absent from the south of the County, which is far warmer than the north, even though the Cannock Chase plateau experiences more severe weather than the lowland.

Axis 2 divides between agricultural areas and urban areas, with the southern and central tetrads split between the top and the bottom of the axis. The tetrads in the 'central belt' of the County (turquoise and green symbols) are almost all at the lower end of the axis with the mainly agricultural variables, while the urban tetrads at the top of this axis clearly have little to do with agriculture. This division into agricultural and urban areas is more apparent than in the PCA analysis of species, where although arable species were seen at the lower end of the axis, the main influence appeared to be species richness, with tetrads at the top containing species from a wide range of habitats. It therefore appears that the species data does not strongly reflect the agricultural variables; this may be because agriculture has few characteristic species.

6.3 PCA with environmental variables shown as passive vectors

Figure 6.16 shows the result of unconstrained analysis of the species data using Principal Components Analysis, with the environmental variables shown as passive vectors, not constraining the analysis. The distribution of species and tetrads on these axes is identical with that shown in Figures 6.1 and 6.2 in Section 6.1 since it is the same analysis.

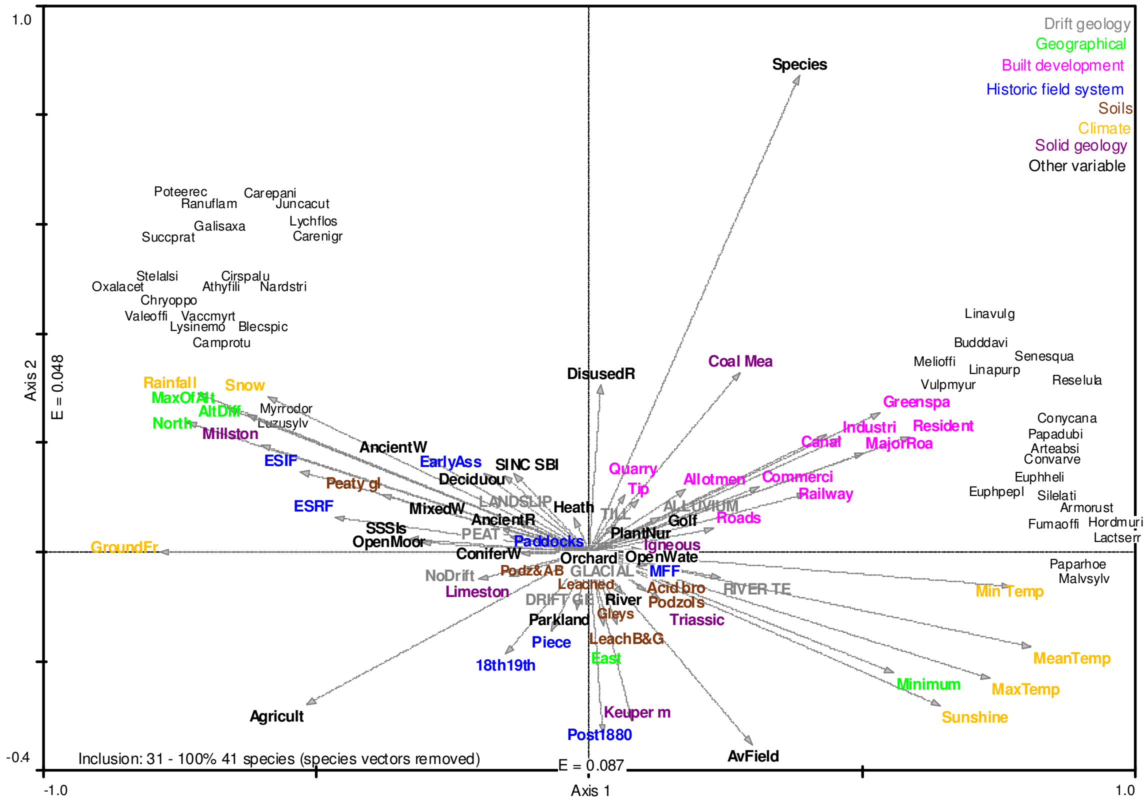
Anthropocentric variables (in pink) increase to the right of the diagram, associated with such species as *Buddleja davidii, Senecio squalidus* and *Hordeum murinum*. Other variables are those associated with a warmer climate, large fields and coal measures. The corresponding tetrads are mainly those from the south of the County, as is clear from the inset diagram. On the left of the diagram are species of non-eutrophic, non-intensively managed habitats. The variables most strongly associated with the left of the diagram are those of cooler climates and higher altitudes and Millstone Grit geology. The corresponding tetrads are from the northernmost parts of the County.

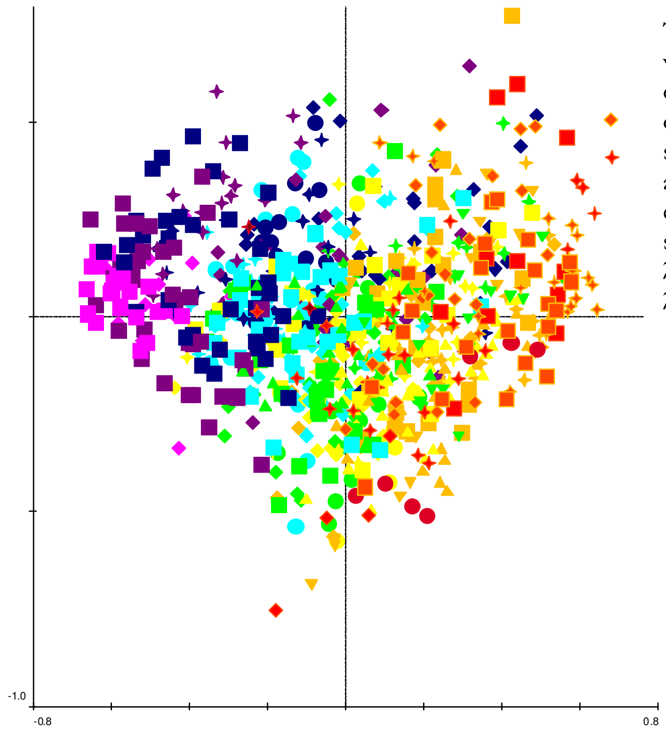
Number of species per tetrad is the most prominent variable on Axis 2, near the top of the diagram, while large field size and agricultural land are at the lower end of the axis. Number of species is not strictly an environmental variable; rather it can be said to be a product of landscape and ecology, generally the more heterogeneous the landscape, the higher the diversity (Parviainen *et al.*, 2010; Vanderpoorten *et al.*, 2005; Wohlgemuth, 1998).

The opposing position of species diversity to the agricultural variables indicates that lower species diversity is associated with agricultural land. By contrast, higher species diversity appears to relate to anthropocentric variables and species, and to a slightly lesser extent to the upland variables and species of unimproved habitats.

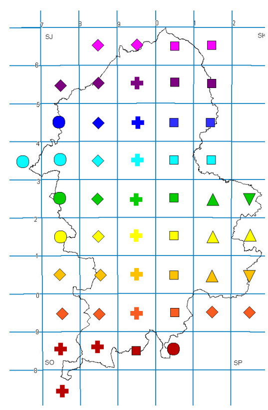
As outlined in Section 6.2, the historic field system categories can be used to indicate the degree of agricultural improvement. The most modern field systems, 'post 1880s' at the lower end of Axis 2, and the slightly earlier '18^{th} / 19^{th} Century' fields and Piecemeal enclosure, appear to be associated with intensive agriculture. The other categories are earlier and are found higher up, mainly to the left of the diagram, indicating that these types of field are associated with species of unimproved habitats. Woodland variables, in particular ancient woodland, also appear to be associated with this part of the diagram.

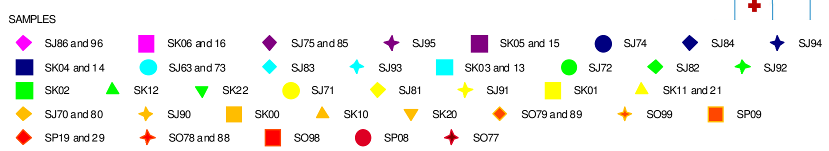
Figure 6.16 – Unconstrained analysis showing environmental variables*





This Principal Components Analysis (PCA) was performed on 813 samples. It is based on a covariance matrix (species are centred only and weighted by their variance). The scaling focus on inter-species correlations and the scores are not transformed after axes extraction so the length of arrow reflects the standard deviation of species.
$\lambda1$ = 8.7% of species variance;
$\lambda1+\lambda2$= 13.5% of species variance





* *Insets show location of tetrads on axes, and location of tetrads in County.*

Drift geology and soil categories are mainly situated towards the centre of the diagram, meaning that their influence on both axes is lower than other categories.

In conclusion, the main influence on one side of Axis 1 are cold climate, higher altitudes and non-intensive agriculture. This side has semi-natural habitat indicated by the species shown, and by the variables relating to habitats such as Ancient Woodland and Sites of Special Scientific Interest. On the other side of the axis are variables relating to warmer climate and industrial and residential development. This confirms the findings of the species analysis for Axis 1.

On Axis 2, species number is the strongest variable, counter to which at the other end are mainly variables related to agricultural improvement, such as large field size. In the species analysis, water / wetland was also perceived to have an effect on Axis 2, with the most species-rich areas likely to have wetlands or water among their habitats. The variable for canals is towards the top of the axis, but rivers and River Terrace drift geology are below the centre, with open water at the centre. It is probable that none of these variables is a good indicator of wetland and, outside the towns, they are likely to be most associated with areas of less agricultural improvement.

6.4 Redundancy analysis

6.4.1 Treatment of variables

Individual selection of the variables resulted in 7 variables being rejected from the model as not significant ($p<0.01$) (Table 6.7). These included plant nurseries and orchards (land uses with very low hectarage in the County), one geological type (Igneous), drift geology (Landslip and unspecific drift), one soil type (Podzols and acid brown) and one of the historical field patterns (Paddocks). The variable 'podzolised acid brown soils' had negligible variance, and was rejected automatically during the analysis, while 'minimum altitude' was similarly automatically removed because it is totally collinear (see below).

The Variance Inflation Factor (VIF) is a measure of the correlation between any one variable and all the others. Greater than 20 is considered to be a large VIF (ter Braak and Šmilauer, 2002). A variable with a high VIF is closely correlated to other variables, and the higher the VIF, the less the contribution the variable makes to the regression equation. Totally collinear variables have a VIF of 0 (Section 4.3.4); in this case only 'minimum altitude' had a VIF of 0.

Very high VIFs were shown for agriculture, residential, all solid geology types and most drift geology types excluding peat (Table 6.8). The variables with the largest VIF in each category of variable were removed from the model singly and the results examined. Examples of the results are shown on the right hand side of the table. Where 'no drift' was removed from the model, for example, the VIFs of all drift geology categories reduced to well below 21, that is they no longer showed multicollinearity. The high VIFs for other variables were not affected. Where 'agriculture' was removed from the model, all VIFs for the land cover categories reduced (only nine are shown in the table). On removing 'agriculture', 'no drift' and 'keuper marl' from the model together, all VIFs of remaining variables were below 20.

This shows that there are four groups of variables where multicollinearity is important: altitude, solid geology, drift geology and land cover. This might be expected, however, because within each group, individual variables usually do not occur in the same area, for example high and low altitude. Variables can occur in the same tetrad, for example housing and agriculture or two solid geology types. However, across all of the tetrads the usual situation is that a high percentage cover of housing will mean a low cover of agriculture and *vice versa*.

In order to carry out the RDA, the most collinear variables, 'Keuper Marl', 'Agricultural' and 'No drift' were removed as recommended by Blanchet *et al.,* (2008). Allowing for the variables previously removed, this left 60 variables in the final analysis.

Table 6.7 - Significance of variables*

Variable	**F**	**p**	**Variable**	**F**	**p**
Mean Temperature	51.74	0.005	East	6.64	0.005
Ground frost	47.64	0.005	Mixed woods	6.17	0.005
Minimum temperature	46.04	0.005	No drift	5.62	0.005
Rainfall	45.95	0.005	18th and 19th Century enclosure	5.60	0.005
Max temp	45.72	0.005	Deciduous woods	5.37	0.005
North	45.01	0.005	Disused railway	5.23	0.005
Maximum altitude	44.29	0.005	Rivers	5.17	0.005
Number of species	43.88	0.005	Conifer woods	5.02	0.005
Snow	36.79	0.005	Miscellaneous floodplain fields	5.01	0.005
Sunshine	36.34	0.005	Early assarts	4.97	0.005
Minimum altitude	36.31	0.005	Alluvium	4.77	0.005
Difference in altitude	36.14	0.005	Allotments	4.57	0.005
Millstone grit	34.50	0.005	Ancient replanted woods	4.15	0.005
Residential	34.23	0.005	Heathland	3.93	0.005
Agricultural land	31.71	0.005	Site of Biological Importance	3.88	0.005
Greenspace	30.73	0.005	Till	3.53	0.005
Major roads	22.83	0.005	Quarries	2.99	0.005
Early small irregular fields	22.55	0.005	Leached brown and gley soils	2.97	0.005
Industrial land	21.50	0.005	Peat	2.75	0.005
Canals	19.14	0.005	Podzols	2.70	0.005
Early small rectilinear fields	17.27	0.005	Tips	2.57	0.005
Coal measures	16.04	0.005	Gleys	2.51	0.005
Keuper marl	15.54	0.005	Golf courses	2.49	0.005
Peaty gleys	14.62	0.005	Parkland	2.37	0.005
Average field size	14.42	0.005	Landslip	2.36	0.01
Railway	14.14	0.005	Open water	2.35	0.005
Sites of Special Scientific Interest	12.58	0.005	Acid brown soils	2.29	0.005
Open moorland	10.69	0.005	Glacial	2.15	0.005
Post 1880 enclosure	10.54	0.005	Igneous geology	1.96	0.01
Commercial land	10.42	0.005	Leached brown soils	1.87	0.005
Ancient woodland	10.21	0.005	Podzols and acid brown soils	1.35	0.035
Limestone	8.56	0.005	Paddocks	1.24	0.06
Piecemeal enclosure	7.45	0.005	Orchards	1.20	0.15
Triassic	7.41	0.005	Drift unspecific	1.08	0.235
River terraces	7.39	0.005	Podzolised acid brown	Negligible variance	
Other roads	7.15	0.005	Plant nurseries	1.02	0.435

Key
Variable significant (p<0.01)
Variable is collinear
Variable not significant

Number of permutations in Monte Carlo tests = 199

Table 6.8 – Variance Inflation Factor (VIF) for all variables*

All variables analysed								**'No drift' removed**	
Variable	**VIF**	**Variable**	**VIF**	**Variable**	**VIF**	**Variable**	**VIF**	**Variable**	**VIF**
Species	1.79	Industri	39.74	ESRF	2.31	GLACIAL	1093.39	GLACIAL	1.0287
East	2.59	Commerci	7.92	MFF	3.34	TILL	9696.37	TILL	1.0893
North	8.88	Greenspa	37.52	Piece	2.87	RIVER TE	2116.29	RIVER TE	1.0646
Deciduou	14.20	Agricult	785.58	Post1880	4.08	ALLUVIUM	1832.58	ALLUVIUM	1.0515
MixedW	28.00	Parkland	21.64	Triassic	29628.34	PEAT	26.88	PEAT	1.0177
ConiferW	37.20	Golf	7.79	Coal Mea	24825.47	AltDiff	6.62		
OpenWate	9.35	Allotmen	1.32	Keuper m	35998.92	MaxOfAlt	19.80	**Agriculture removed**	
Canal	1.83	OpenMoor	23.90	Millston	15274.48	Minimum	0.00	Resident	6.67
River	3.06	Heath	8.79	Limeston	2836.52	GroundFr	8.64	Industri	2.50
Quarry	10.02	AncientW	2.11	Acid bro	1.59	Rainfall	7.89	Commerci	1.53
Tip	1.84	AncientR	1.84	Leach B & gleys	2.55	MeanTemp	12.76	Greenspa	3.65
DisusedR	1.22	SINC SBI	1.56	Leached	1.37	Snow	6.27	Parkland	1.37
Railway	1.75	SSSIs	2.95	Gleys	1.43	Sunshine	6.13	PlantNur	1.09
MajorRoa	2.32	18th19th	4.23	Peaty gl	2.07	Min Temp	7.46	Golf	1.28
Roads	1.87	EarlyAss	1.33	Podzols	1.78	MaxTemp	9.43	Allotmen	1.26
Resident	323.66	ESIF	3.44	NoDrift	10960.64	AvField	2.04	OpenMoor	2.46

Key
VIF exceeds 20
VIF exceeds 300
Completely multicollinear

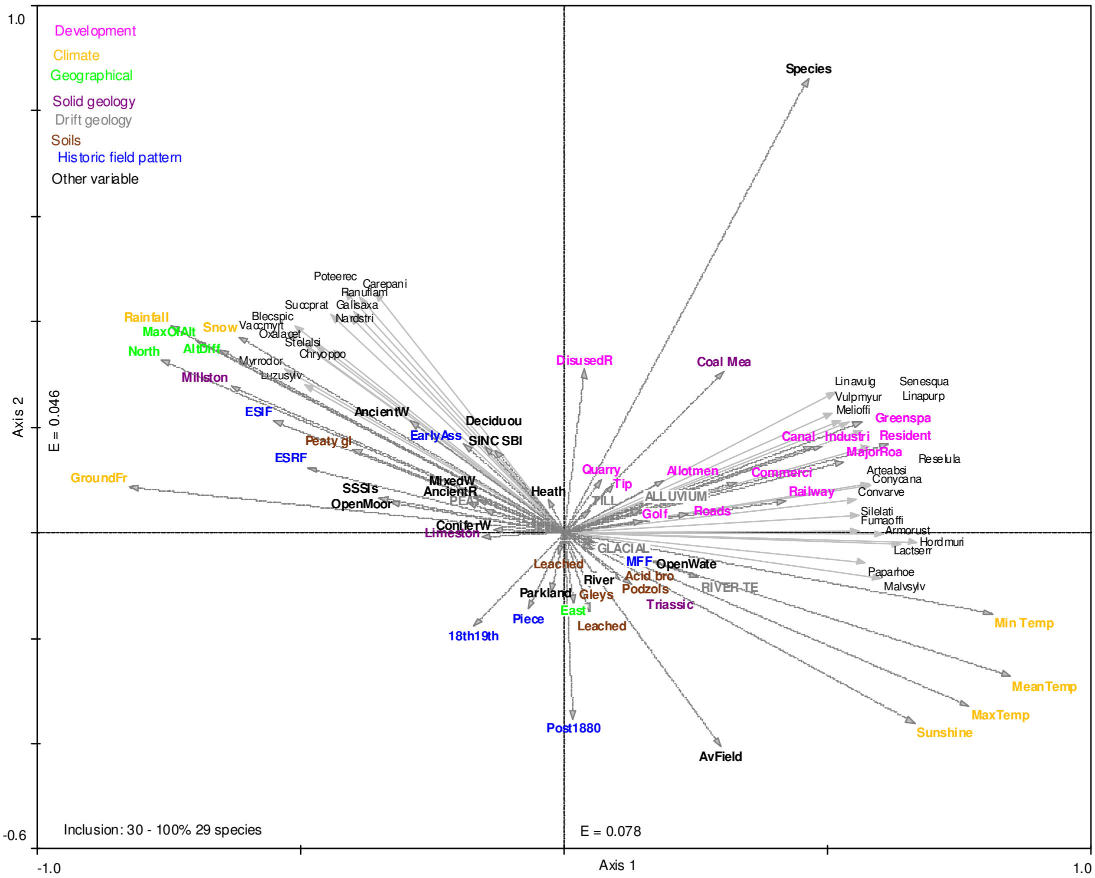
* *Right hand column shows effect of removing one variable at a time on VIFs of related variables (selected variables shown)*

6.4.2 Redundancy analysis with all variables

Figure 6.17 shows the result of the analysis with the remaining variables; the following Figures show the variables with the highest scores for each axis, which are discussed in the text following each one.

The most striking quality of the constrained analysis as shown in Figure 6.17 is that the results are very similar to the unconstrained analyses for the species and the variables separately, showing that the variables chosen go a long way towards explaining the species distribution. It is important to note, however, this is not necessarily statistically significant because where data has large numbers of variables it is notoriously problematic to select appropriate numbers of significant variables (Blanchet *et al.*, 2008) (Sections 4.3.4 and Chapter 7). The following sections (6.4.3 – 6.4.6) show the different axes with their most strongly associated variables as an indication of the trends.

Figure 6.17 - Redundancy analysis, showing Axes 1 and 2



This Redundancy Analysis (RDA) was performed on 813 samples. It is based on a correlation matrix (species are centred only and weighted by their variance). The scaling focus on inter-species correlations and the scores are transformed after axes extraction so the distance from centre is a measure of fit with the ordination diagram. Variables removed as shown in Table 6.7. λ_1 = 7.8% of species variance; =28.7% of species / variables relation, $\lambda_1+\lambda_2$= 12.4% of species variance =45.5% of species / variables relation. First canonical axis eigenvalue = 0.078, F-ratio = 63.647, P-value = 0.005, all canonical axes Trace = 0.272, F-ratio = 4.674, P-value = 0.005, 199 permutations under reduced model.

6.4.3 Axes 1 and 2 and their most strongly correlated variables

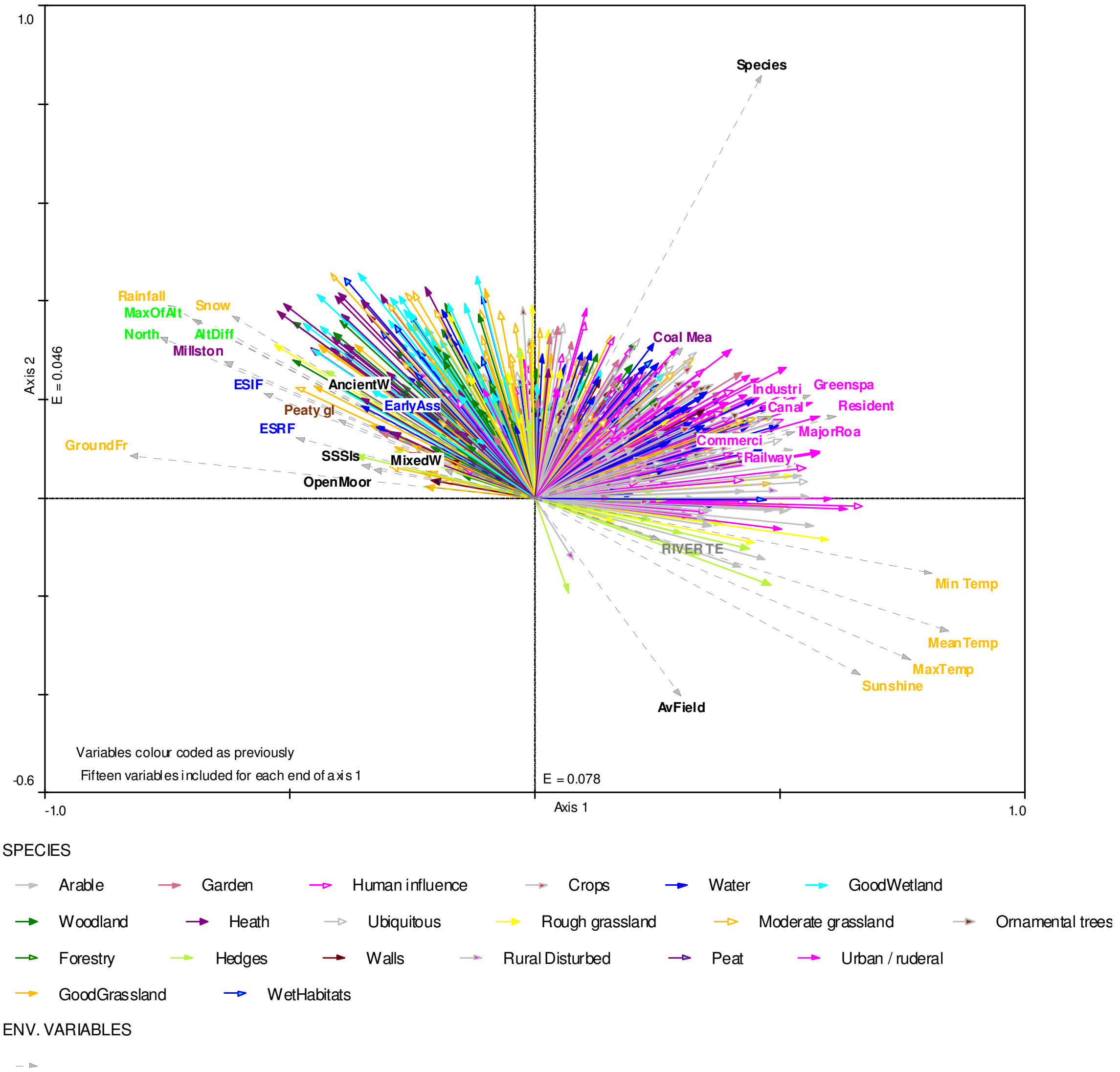
In Figure 6.18, only the fifteen variables most strongly increasing, and the fifteen most strongly decreasing, with the trend on Axis 1 are shown, with the tetrad locations in the County and Figure 6.19 shows 45 species for the two axes. In Figure 6.18, all species are shown, using an indicative colour coding for their habitat preferences. These habitat preferences were taken from descriptions in the 'New Atlas of the British Flora', and the most obvious habitat described was used. Many species occur in more than one habitat, so often the decision as to which habitat to use was arbitrary. However, the colour coding when viewed *en masse* does give an overall impression of the prevailing habitats for each part of the diagram. This method was also used in subsequent diagrams.

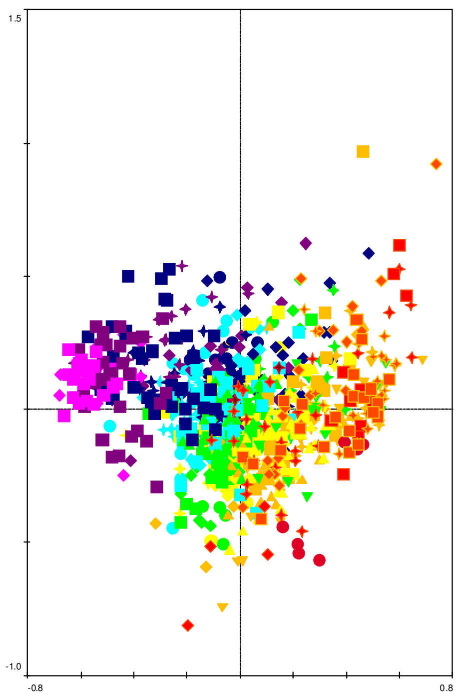
The variables may be seen clustering at the two ends of Axis 1 in Figure 6.18. This constrained axis is very similar to the first axis in TWINSPAN, and to the unconstrained axis in the species and variables analysis in Sections 6.1-6.3 above. It clearly reflects an increase in human influence from left to right and demonstrates that this is the strongest trend in the data.

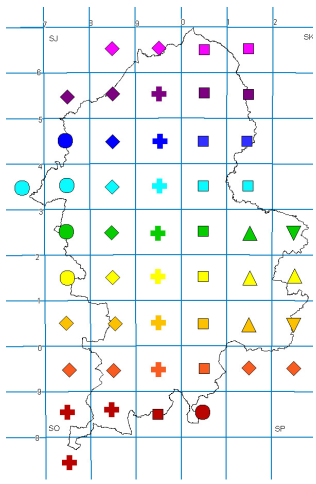
Figure 6.19 shows 45 indicative species on Axes 1 and 2, to the right of the axis are indicators of human influence, with species including *Reseda luteola*, *Conyza canadensis* and *Artemisia absinthum*. The environmental variables to the right include those of habitation, residential, industrial and commercial development with associated transport infrastructure including 'A' roads and motorways (Major roads category). The warmest annual average temperatures and most days of sunshine are also associated with this side of the axis, which is in keeping with the suggested Eurosiberean Southern-temperate attributes for this part of the County (Section 5.2.1, Page 62). Greater altitudes are shown to the other side of the axis, so low altitudes can be inferred on this side. The association of coal measures geology with this side of the axis shows the industrial history of the Black Country (Teagle, 1978) and Stoke-on-Trent conurbations.

Most of the urban tetrads are on this right-hand side of Axis 1, as is indicated in the inset diagram. The number of species per tetrad was also used as a variable, and it is apparent that relatively larger numbers of species are found in these urban areas.

Figure 6.18 – RDA showing Axes 1 and 2 with species coded according to habitat*



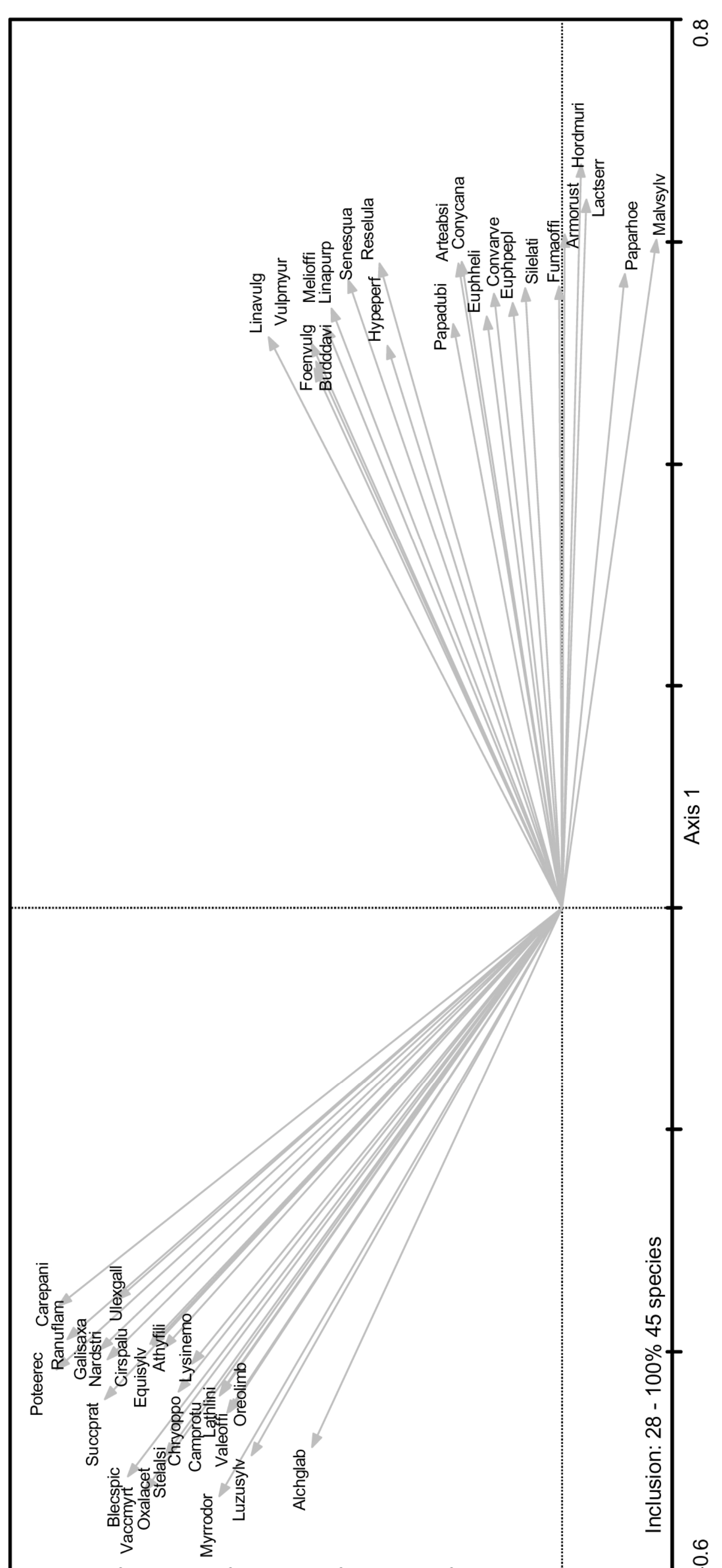




This Redundancy Analysis (RDA) is as described in Figure 6.17.

**Habitat coding according to the New Atlas of the British Flora(Preston et al., 2002), insets: Location of tetrads on Axes 1&2, location of tetrads in County*

Figure 6.19 - RDA Axes 1 and 2 showing species*



**All parameters as for Figure 6.18*

The main variable used that indicates agricultural activity is 'average field size', where a large field size might be used to indicate agriculture that is more intensive. The right side of Axis 1 has an association with large field sizes, where it is expected to find arable farming and other methods that are reliant on large machinery.

Many tetrads with agricultural land are found on the left side of the axis, however. These appear to have smaller field sizes (an imaginary line extending back from the 'average field size' arrow). The corresponding surviving medieval field patterns (early small irregular fields, early small regular fields and early assarts) show that that field boundaries have not had to be removed to make room for large agricultural machinery and that agriculture is probably relatively unintensive in these tetrads.

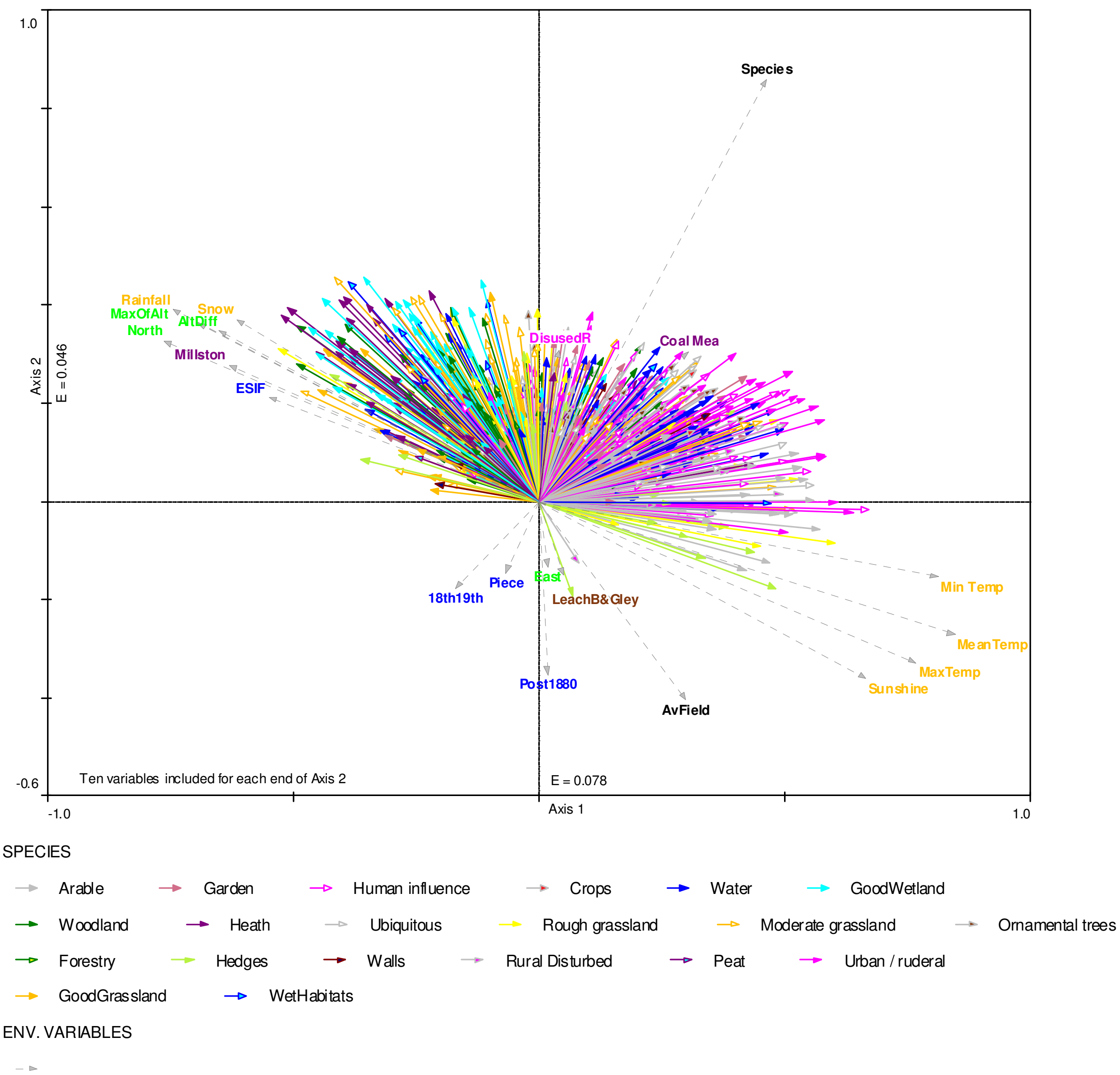
Some of the species associated with the left-hand end of the axis include *Blechnum spicant*, *Succisa pratensis* and *Oxalis acetosella.* Species in this part of the diagram are those of unimproved habitats, many of which are found in the uplands. The proportion of the tetrad designated as Sites of Special Scientific Interest was used as a variable ('SSSI'); these are the most important areas for semi-natural habitats in the County, and have a clear correlation with this side of the axis. Similarly, ancient woodland is associated with the left hand end of Axis 1; these woodlands are the surviving semi-natural woodland above 2 hectares in extent (Natural England, 1999b). Mixed woodland (the Ordnance Survey map category) is also shown on the diagram, it has a weaker association than Ancient Woodland, and 'deciduous woodland' does not appear, being even more weakly associated with this axis.

The environmental variables with the strongest association with the left side of the axis are those of high altitude, northern latitude and cold, wet climate with more days of snow lie and ground frost than the rest of the County, supporting the view (Section 5.2.1.3) that the main division in the data is in part due to biogeographical differences. In the two inset diagrams it can be seen that the tetrads on the left-hand side of the axis are those from the north of the County including the Leek Moors, the limestone valleys to the north-east, and the areas around Stoke-on-Trent. Returning to the main diagram in Figure 6.18, both maximum altitude and the greatest differences between maximum and minimum altitude are also associated with the left-hand end of Axis 1.

The geology is associated with Millstone Grit, and it can be imagined that soils are often thin as there is also a relationship with the absence of drift geology. Peaty gleys is the only soil type that appears on the diagram, and might be expected to be found in the wetter areas of moorland at the left-hand end. With the species shown including *Vaccinium myrtillus* and *Nardus stricta* and these types of geology and soil, the appearance of the open moor category here is not surprising. The diagram also suggests either that that there is little variation in species richness in relation to Axis 1 (and hence to industrialisation), or that the urban tetrads are at least as species rich as the extensively-managed areas of the vice-county.

The centre of the axis has mainly tetrads from the centre of the County, where one might expect a proportion of agricultural land to be balanced with areas of built development. There must be a corresponding lack of semi-natural habitats and a lack of places where the human-influenced species can flourish, such as wasteland.

Figure 6.20 - RDA as Figure 6.17, but with most prominent variables for Axis 2



Tetrad locations and species as Figure 6.19, all parameters as Figure 6.17.

Axis 2 is shown in Figure 6.20, with the ten environmental variables most strongly associated with either end of the axis. The top of axis 2 is clearly strongly connected to species diversity with this variable increasing towards the top of the diagram. It is clear from the colour coding that the top of axis 2 has the majority of species associated with it, from a range of habitats, including wetlands, grasslands, heathlands and urban areas. Species of open water and woodland generally have a weaker association with the top of the axis, indicated by shorter arrows in dark blue and dark green.

Figure 6.21 shows indicative species for Axis 2 (with the right hand side equivalent to the top of Figure 6.20). This side shows many species of wetland habitats, such as *Carex panicea*, *Juncus articulatus* and *Ranunculus flammula*. Species of grassland such as *Rhinanthus minor* and *Carex ovalis*, of heathland, for example heather *Calluna vulgaris* and *Vaccinium myrtillus*, and of urban areas, such as *Sisymbrium orientale* and *Lysimachia punctata* are also found to this side of the axis. Species of open water are not seen in the figure, as they are less well explained by the two axes.

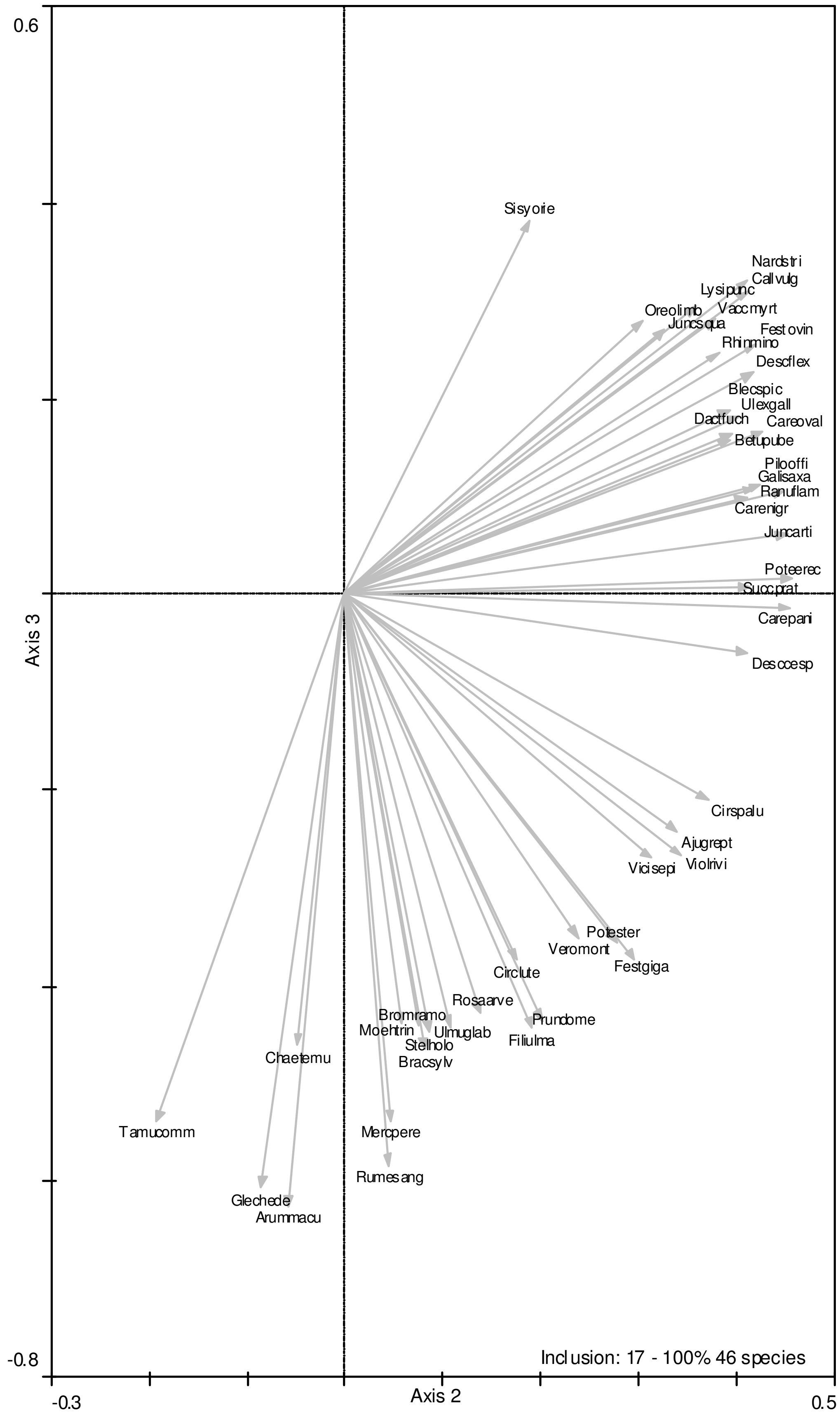
In contrast, the left side of the axis (Figure 6.21), has only weakly associated species and these appear to be confined to arable species, and those of hedges, including *Tamus communis*, *Glechoma hederacea* and *Arum maculatum*. Arable species are shown by grey arrows with grey fill to the lower right of Figure 6.20 (along with light green hedge species); they are not frequent enough to appear in Figure 6.21, but include species such as *Viola arvensis* and *Veronica persica*. These species are largely species of dry to moist habitats, compared to the high proportion of wetland species seen on the other side.

The strongest indicators on the lower part of the axis are those of warm temperatures and large, more modern fields (18^{th} and 19^{th} Century enclosures). The only soil type notably associated with this side is Leached Browns and Gleys, which are capable of being agriculturally improved. These warm, lowland and agricultural characteristics may well be associated with species of arable situations. Probably hedges are the only other habitat that is not confined to the other parts of the County, but is found in association with the farmed areas too.

By comparison, the variables for the top of Axis 2 include those of high altitude, northern latitude and high rainfall and snowfall and therefore more severe conditions that are less suitable for agricultural improvement. The Millstone Grit geology would also support this view. The association of Coal Measures geology, which is capable of supporting intensive agriculture in some areas of the County, for example west of Stoke and around Cannock, appears to mainly be linked to areas of urban development where agriculture would be largely ruled out.

It therefore appears that Axis 2 separates the agriculturally improved areas of the County and the more species-rich urban and upland components. This species richness is likely to correspond to habitat richness, incorporating semi-natural habitats, remnants of semi-natural habitats and post-industrial habitats. This is demonstrated in the inset diagram where most tetrads from the central belt of the County lie towards the lower end of the axis (yellow, green and turquoise symbols). The variable 'east' is also associated with the lower end of the axis, although substantial parts of the west are under intensive agriculture.

Figure 6.21 - RDA Axis 2 and 3 showing species*



**All parameters as for Figure 6.20*

6.4.4 Axis 3 and its most strongly correlated variables

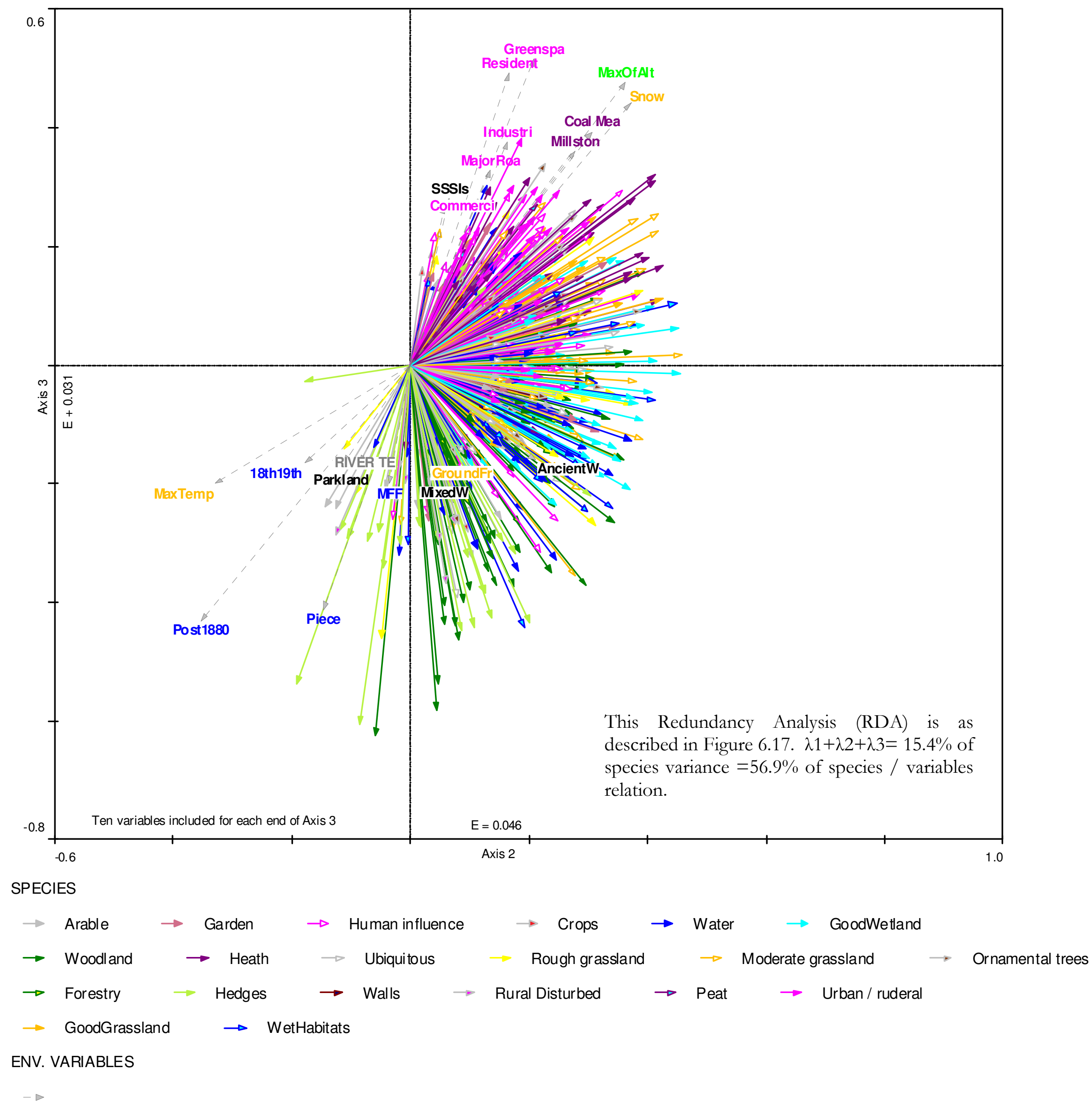
Axis 3 with variables and habitat-coded species is shown Figure 6.22, with indicative species shown in Figure 6.21.

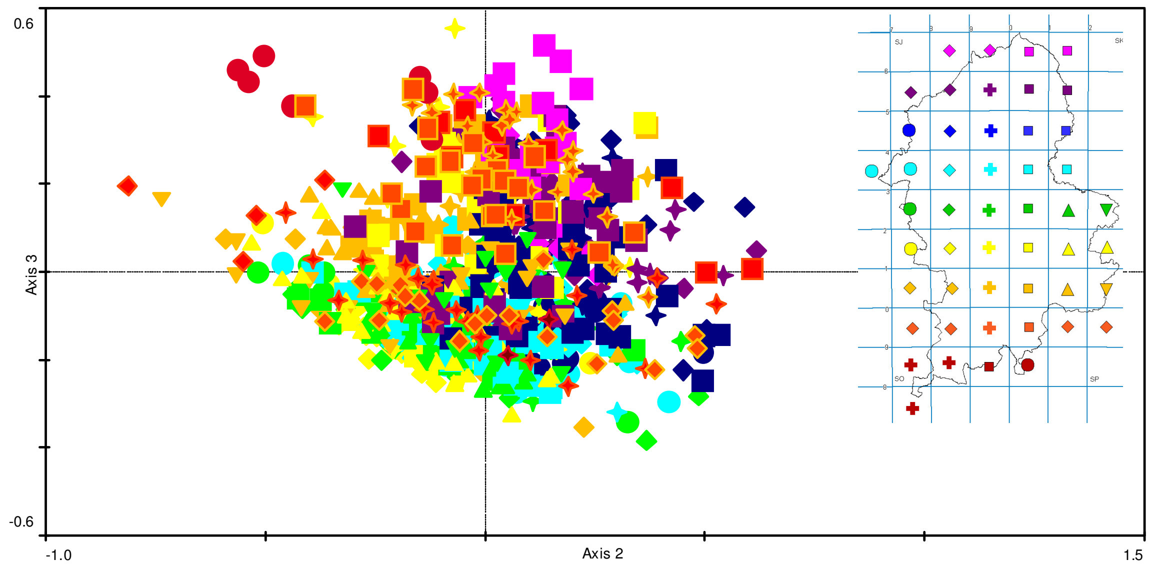
At the lower end of the axis are predominantly species of hedges and woodlands, with variables that include Ancient Woodland and mixed woodland as might be expected with these species. The lower end also has variables that include more modern field types, such as post-1880 enclosures, and there are grey arrows showing arable species. Parkland is associated with the lower end of the axis – most parkland in the County is improved and intensively managed grassland or arable (Radford *et al.*, 1995-2000; Cadman *et al.*, 2004 - present). Average field size is not shown on the diagram, but large fields have a relatively weak association with the lower end of the axis in this RDA.

Species vector colours for the top of Axis 3 show urban, heathland and grassland species, while wetland and open water vectors are closer to the centre. At the top of the axis are an apparently odd combination of variables: high altitude and snowfall together with development indicators such as residential and commercial land. The geological categories are likewise mixed with Coal Measures and Millstone Grit. The top of the axis might also appear to be associated with habitat richness because Sites of Special Scientific Interest (SSSIs) are shown here too, although SSSI are probably weakly associated with woodlands as only 11 out of 64 are wooded, or partly wooded. Overall, the top of the axis is mainly distinguished by an apparent lack of indicators or species of shaded conditions; therefore, it contains variables and species of open habitats.

It therefore appears that Axis 3 separates species of shaded habitats such as woodlands and hedges at the lower end from species of open habitats including those of heathland, grassland and urban areas at the top. The juxtaposition of shaded habitats with intensive agriculture is also apparent at the lower end of the axis, and this was seen in both the TWINSPAN analysis (Section 5.3, Group 01) and in the unconstrained analysis (Section 6.1).

Figure 6.22 - RDA Axes 2 and 3 showing variables for Axis 3 with all species





Insets: Location of tetrads on axes 2 & 3, location of tetrads in County.

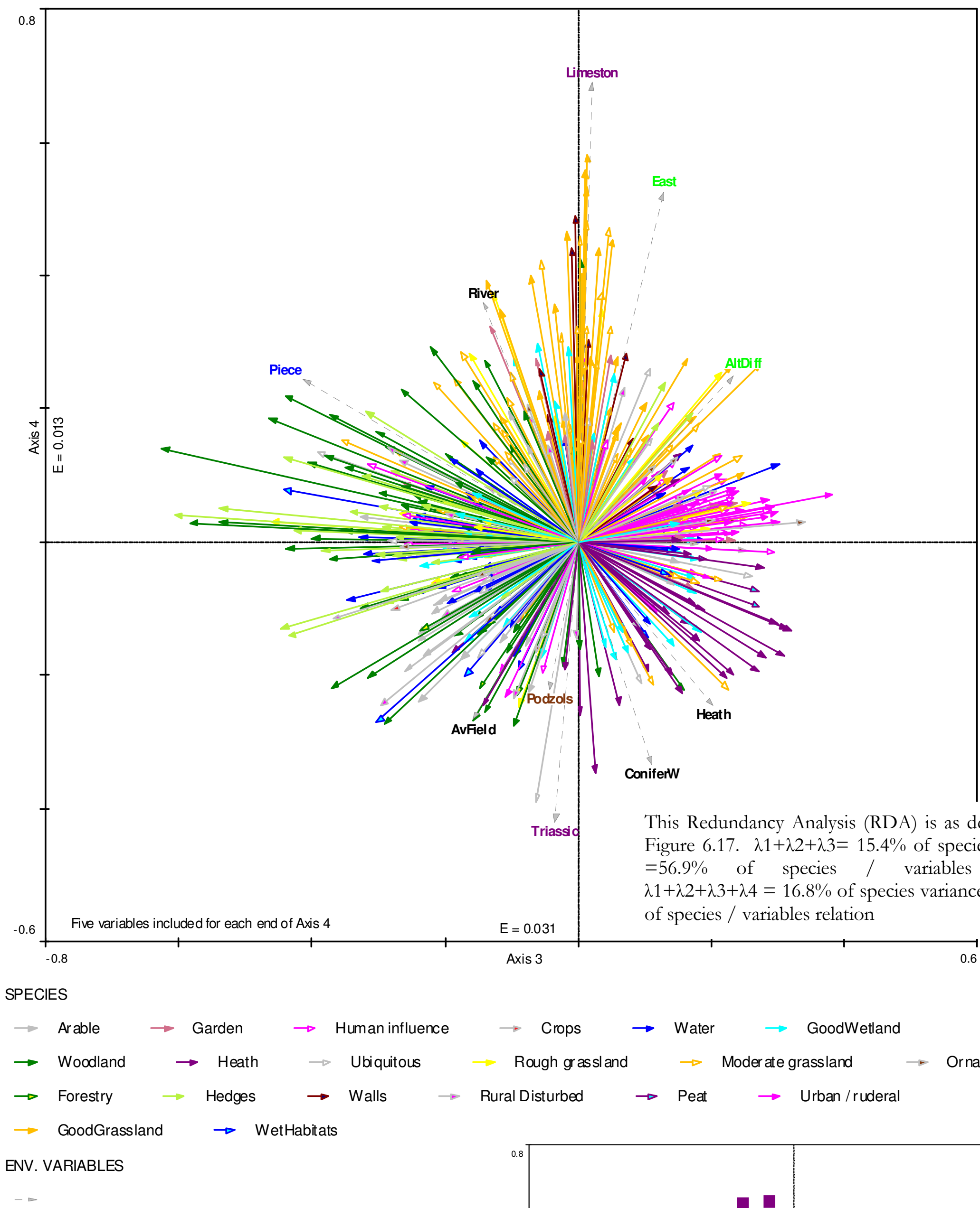
6.4.5 Axis 4 and its most strongly correlated variables

Figures 6.23 and 6.24 show axes 3 and 4 of the RDA. It is clear that soil base status is the main trend on this axis, and that the constrained analysis does not differ greatly from the unconstrained analyses (Sections 6.1 – 6.3). The selection criteria have been set too low to show the heathland species that are found in the lower right quadrant of Figure 6.24. However *Digitalis purpurea* in the lower centre of the diagram has an Ellenberg pH value of 4 (Hill *et al.*, 1999), showing the general trend for this part of the axis, and the purple colour of heathland species in Figure 6.23 makes this clear. At the top of the axis are species similar to those shown for the unconstrained analysis (Figure 6.12), and indicating calcicolous and / or base enriched conditions.

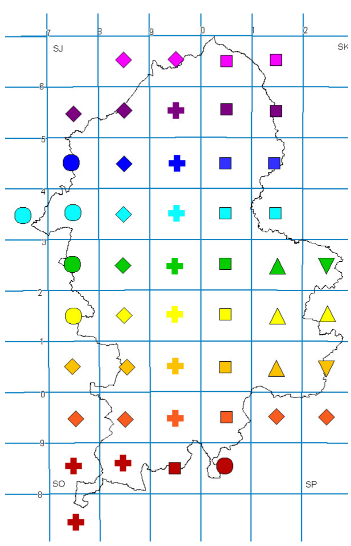
As might be expected, the most prominent variable for the top of the axis is Limestone geology. All of the limestone in the County is found on the east side, and 'east' is the next most prominent variable. The next variable is 'river', indicating overall length of river per tetrad. The limestone geology is strongly related to the Hamps, Manifold and Dove River Valleys, so this might be expected. However, other rivers in the County have different geology, and this is probably just a reflection that most of the rivers are on the east side of the County, flowing towards the Trent.

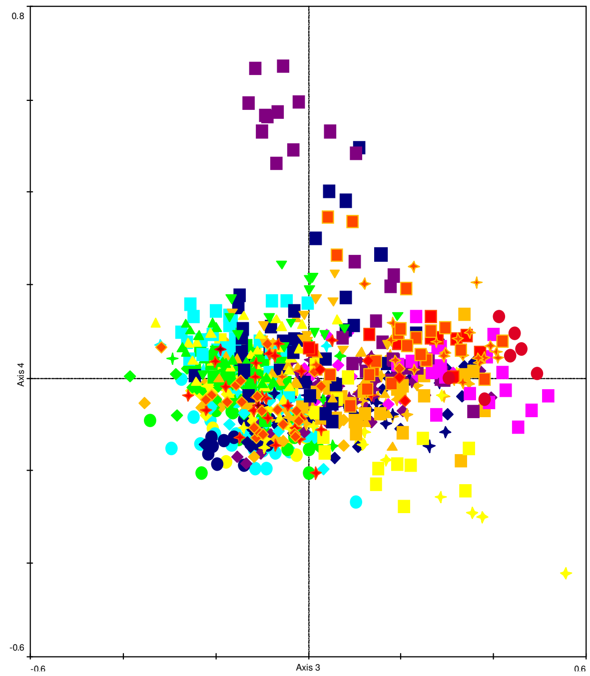
At the lower end of the axis, the most prominent indicator is (Sherwood) Triassic geology, which is near the surface on Cannock Chase, around Lichfield, the south west of the County around Kinver, and in a band across the County to the south of the Stoke conurbation. A confirmatory variable here is 'heath', the proportion of heathland shown on Ordnance Survey maps. Conifer plantations are associated with the lower end of Axis 4 – most of the large conifer plantations are on heathy sites, such as Maer Hills, Swynnerton Park, Burntwood and Bishops Wood in the northwest, Cannock Chase plantations, and The Million near Kinver. Even on the complex geology of the Churnet Valley (Appendix D.1), the conifer plantations are mainly on the drier, acidic soils.

Figure 6.23 - RDA Axis 4



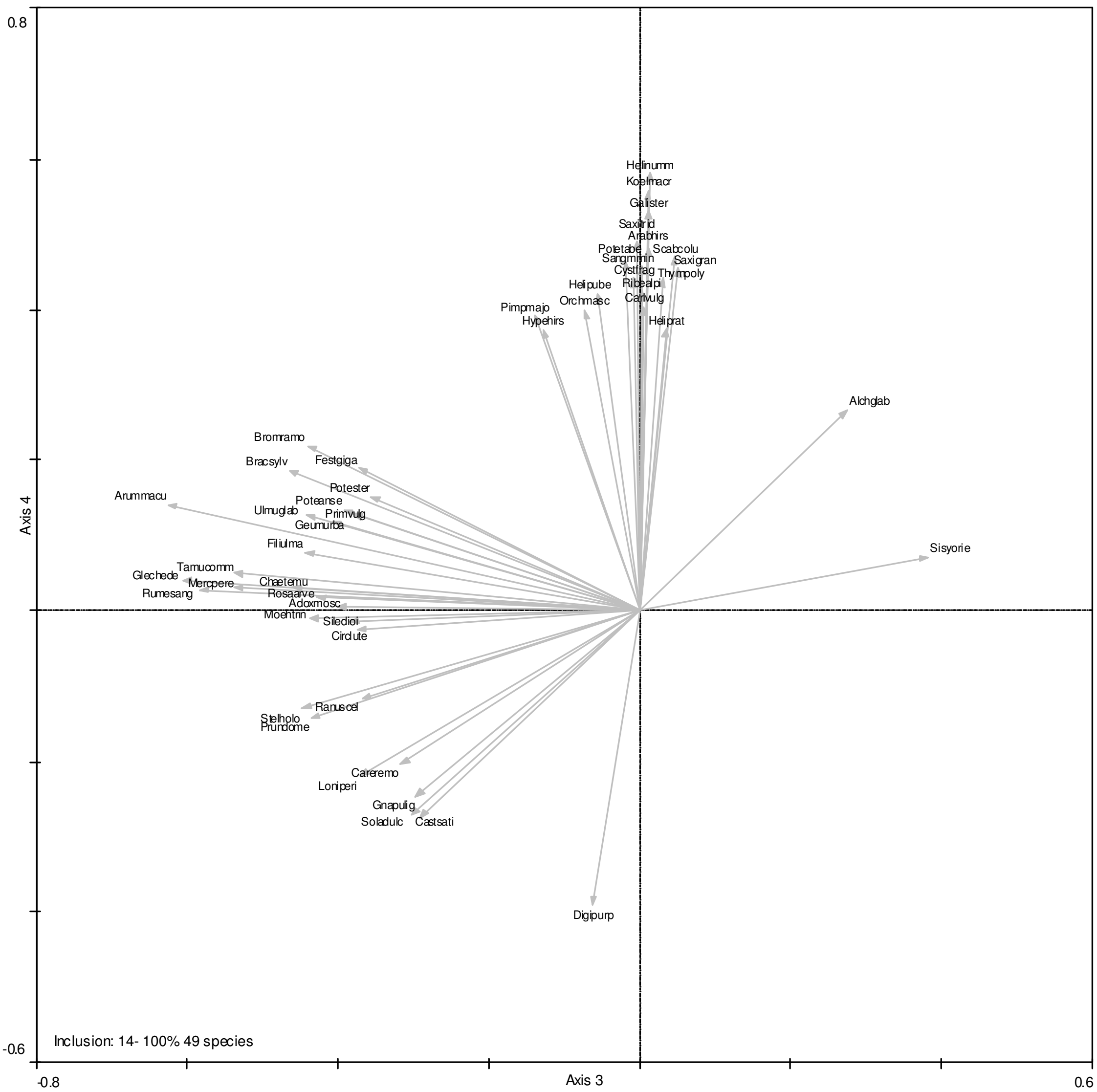
This Redundancy Analysis (RDA) is as described in Figure 6.17. λ1+λ2+λ3= 15.4% of species variance =56.9% of species / variables relation, λ1+λ2+λ3+λ4 = 16.8% of species variance = 61.8% of species / variables relation





Insets: Location of tetrads on axes 2 & 3, location of tetrads in County.

Figure 6.24 – RDA Axis 4 with indicative species



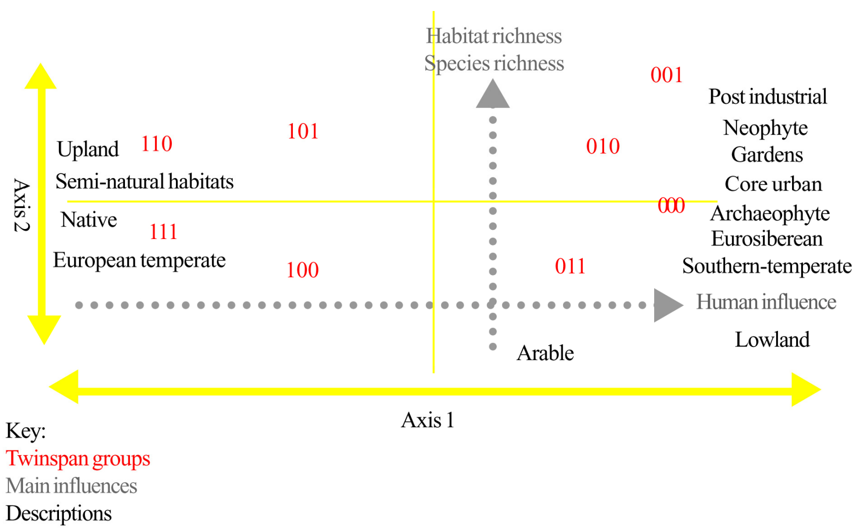
6.5 Summary of unconstrained and constrained analysis

Unconstrained analysis using CANOCO suggested that four axes of variation: human influence, water, shade and soil pH, can be used to describe the distribution of species in Staffordshire.

Unconstrained analysis of the species data with the environmental variables, showed that the main influences on Axis 1 are cold climate, higher altitudes and non-intensive agriculture, with semi-natural habitat countered by warmer climate and development on the other side, which confirmed the findings of the species analysis. However, this unconstrained analysis produced a slightly different interpretation to the species analysis for Axis 2, showing species number as the strongest variable at the top of the axis, although agricultural improvement remained the strongest influence at the lower end.

Constrained analysis gave very similar results to the unconstrained analysis of the species data, with scatter diagrams of species and tetrads for each axis being difficult to distinguish from the ones in Section 6.1. In particular, the first axis is very similar, and the predictive variables in the constrained analysis are climate, latitude, altitude and development, with measures of habitats, species richness and unimproved agriculture also being helpful. The second axis appears confirms that species number is the next most important influence, indicating that the model suggested in summary of the PCA of species might be adjusted to reflect the overriding importance of species richness (and habitat richness) as shown (Figure 6.25), and this indicates that the TWINSPAN interpretation should also change.

Figure 6.25 – Revised summary of Axes 1 & 2



Re-examining the diagrams of TWINSPAN Level 3 and Level 4 groups on Axes 1 and 2 (Figures 6.3, 6.4) shows that each pair of groups has its species-rich and species-poor counterparts. These can be read with the summary (Table 5.16, Page 120) and show that species-richness tends to be associated with those groups that have the most variety of semi-natural habitats (Table 6.9).

Table 6.9 –TWINSPAN / RDA Axis 2 summary showing species richness*

<table>
<tr><td colspan="2">Group 000
Core urban
Gardens / cultivation / walls</td><td colspan="2">Group 001
Urban fringe
Post-industrial wetlands, canals, heaths and other habitat.</td><td colspan="2">Group 010
Urban fringe
Residential - gardens and semi-natural habitats</td><td colspan="2">Group 011
Intensive agriculture</td></tr>
<tr><td colspan="2">Not examined</td><td colspan="2">Not examined</td><td>Group 0100
Base-poor habitat Planting schemes</td><td>Group 0101
Shade and wetland habitats</td><td>Group 0110
Wetland and open water, possibly on floodplains.</td><td>Group 0111
Lacks wetland / open water</td></tr>
<tr><td colspan="2">Group 100
Agriculturally improved / restricted semi-natural habitat</td><td colspan="2">Group 101
Base-poor habitats, probably on thinner soils, elevated altitude</td><td colspan="2">Group 110
Mainly base-poor and wetland habitats, upland</td><td colspan="2">Group 111
Limestone</td></tr>
<tr><td>Group 1000
Lacks habitat and designated sites</td><td>Group 1001
Habitat, nature conservation sites</td><td>Group 1010
Woodland</td><td>Group 1011
Urban influence, lacks woods</td><td>Group 1100
Habitat-rich,</td><td>Group 1101
Moorland, upland, thin soils</td><td>Group 1110
Complex of habitats</td><td>Group 1111
Limestone woods and grassland</td></tr>
</table>

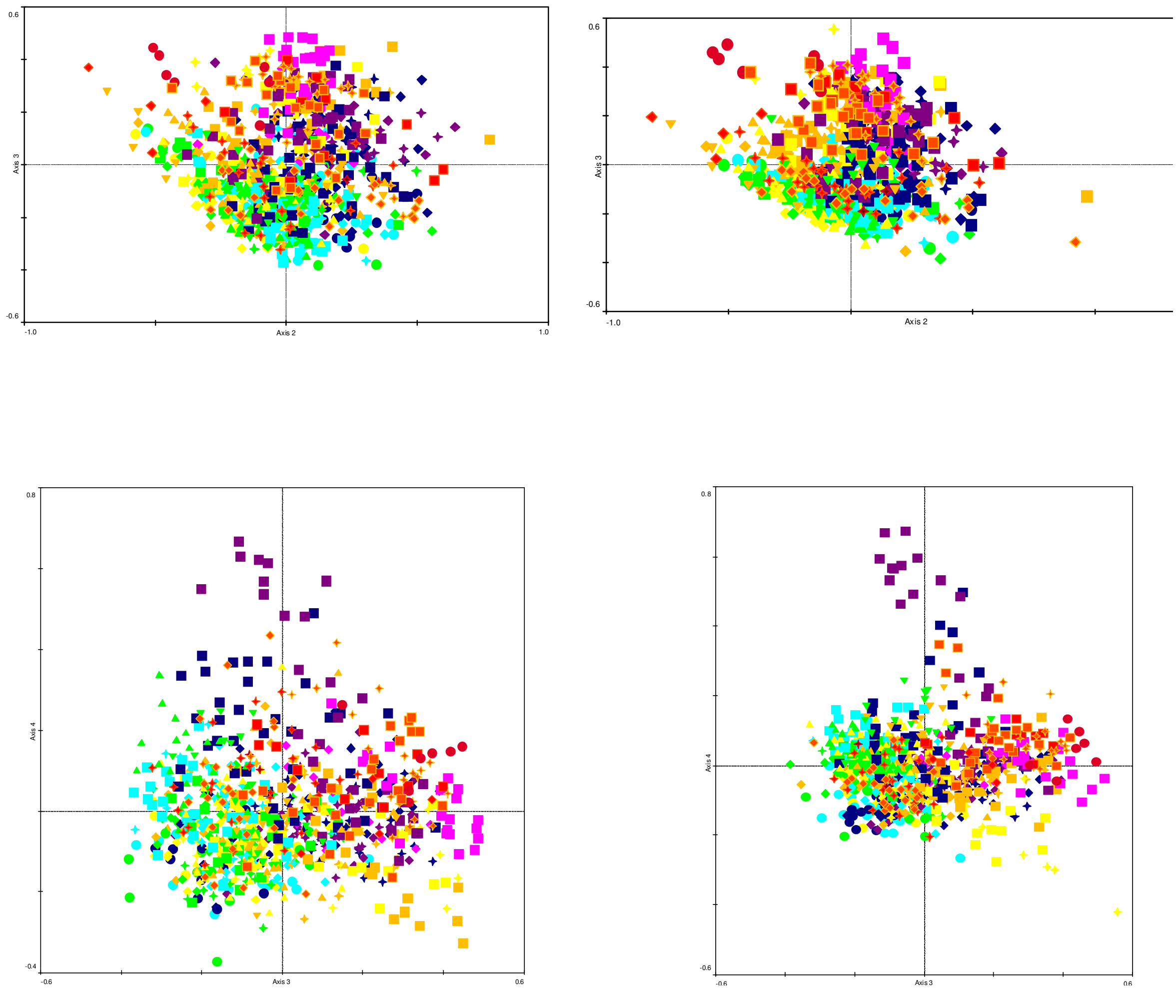
**Species- poor groups shown in pale fill colours, grey text*

Scatter diagrams for tetrads for Axes 3 and 4 show tighter clustering towards the lower end of both axes in RDA than in PCA (Figure 6.26). Since the only difference is that the clustered version is constrained by its variables, this appears to mean that the variables are not predicting the lower parts of each axis well. This indicates that the model provided by the variables is lacking, and that if further variables were added that correlated more closely with the lower ends of Axes 3 and 4 the tetrads would be more spread out.

For Axis 3, most of the variables for the lower end of the axis (shade and agriculture) are relatively weak (short vectors shown in Figure 6.22), compared to those at the top. The variables include Ancient Woodland and mixed woodland, however hedges must be affecting the distribution of species too. A dataset of hedges was not available, which could be an important missing variable. Ordnance Survey Maps also do not distinguish between hedges and fences, so the inverse of field size cannot be used as a proxy for hedges. In Staffordshire, this is further complicated because of the number of northern fields that are bounded by drystone walls.

On Axis 4, it appears that the presence of limestone is the main distinguishing feature at the top of the axis, and this variable separates the species and tetrads well. However, at the lower end of the axis there appear to be a number of heathland areas that are not predicted by the variables ‘heath’, ‘conifer woodland’ and Sherwood Triassic geology.

Figure 6.26 – Comparison of scatter diagrams of tetrads in PCA and RDA



PCA shown on left, RDA on right. Top shows 3rd axes (vertical), bottom shows 4th axes (vertical). On both axes, tetrads are more clustered around the centre of the axis following RDA than with PCA. The diagrams are apparently otherwise very similar.

7 DISCUSSION

7.1 Overview

The present study set out to provide a spatial analysis of a large body of botanical data and to explore the relationships between the ecology and the geographically transitional nature of Staffordshire. The outcomes of the present study are largely concerned with the following topics that were originally raised in Section 1.3.2, which set out questions to be addressed, and aims and objectives. These are briefly outlined below, with indications of where they are discussed:

Biodiversity importance and ecological classification are discussed in Section 7.2, with the classification of the County in Section 7.3.

Spatial variation is discussed in terms of physical and biological characteristics of the County in Section 7.2, including physical and social geography and geological relationships.

Environmental factors are discussed in Section 7.2, with limitations on their use to explain plant distribution discussed in Section 7.6

The selection of indicator species for a variety of uses is discussed in Section 7.4, with suggestions for further work

Section 7.5 discusses the use of analysis to produce nature conservation strategies.

7.2 Characteristics of Staffordshire

7.2.1 Human influence versus semi-natural habitats

In a study of the south-west Finnish Archipelago, Korvenpää *et al.,* (2003) found that the main ecological gradient was caused by human impact. In Staffordshire, an apparently completely dissimilar area, the main floristic trend is between mainly northern areas with a seemingly high proportion of species of non-intensively managed, non-eutrophic habitats including woodland and mainly southern areas characterised by human-influenced species, species of intensive management, and / or species of eutrophic conditions. This apparently steep trend is consistent across all analyses used, and confirmed by analysis constrained by the environmental variables where variables relating to small fields and surviving habitat are associated with the non-intensive parts of the County, and variables relating to development are associated with the intensively human-influenced parts.

Staffordshire appears to be a highly modified and industrialised county, apart from the area around the Peak District. Therefore, one surprising outcome of the study is that a large extent of the County retains so many indicators of semi-natural habitats, a smaller extent of intensively-managed agricultural land, and the remaining urban areas represent only around 10% of the area when defined by plant species composition (Page 76).

The use of historic field pattern characterisation (Staffordshire County Council, 2008) showed that the earlier types of field patterns were related to surviving semi-natural habitat (Page 161). This is probably the first time a comparison between an historical landscape characterisation and a systematic vascular plant dataset has been attempted in the UK, although studies elsewhere have shown correlations between surviving habitat or species diversity and the historic landscape. For example, Lindborg and Eriksson (2004) found that present day grassland diversity in Sweden correlates better with maps from 50 and 100 years ago. A similar effect was detected by Helm *et al.*, (2006) on examining calcareous grasslands in Estonia. The correlation of species data with the historic information in Staffordshire has already been used to support the assertion that these historic landscape patterns need to be protected (D Langley pers. comm.).

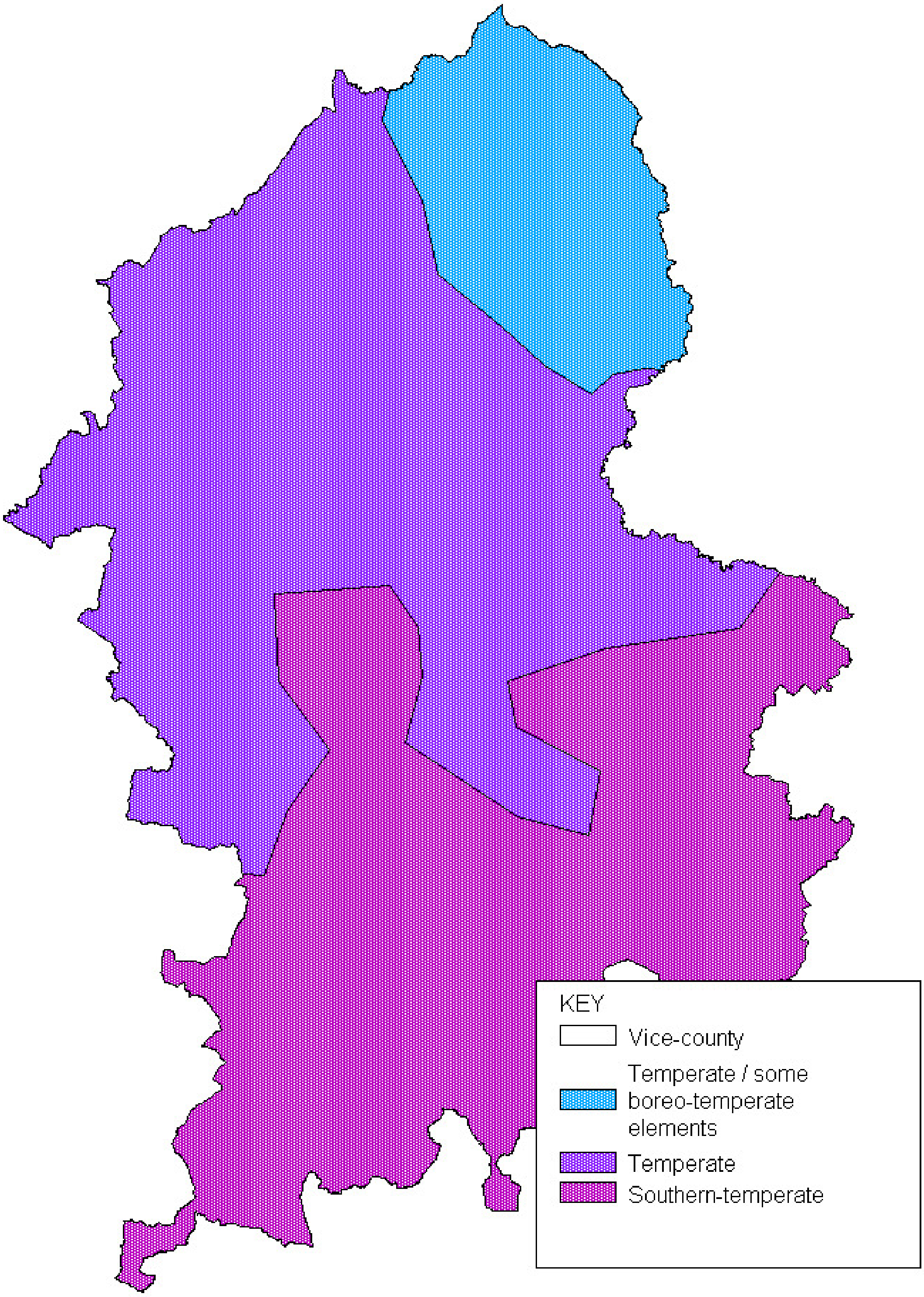
Both Swedish (Lindborg and Eriksson, 2004) and Estonian studies (Helm et al., 2006) suggest that the loss of species diversity has not yet caught up with the loss of landscape features that can be seen now. This has urgent implications for nature conservation in any area where this 'time lag' can be detected, and shows that work in other regions to correlate species diversity and historic data is likely to be very important. The present study offers a technique through which this can be achieved.

7.2.2 Biogeography

Figure 5.4 (Page 68) gives the biogeographical attributes for the upland and lowland / urban parts of Staffordshire, which are discussed in Section 5.2.1 (Page 62). The lowland and the south are clearly differentiated from the upland and most of the north of the County which are characterised by species of a European temperate climate. Typical species also include those of Eurosiberian boreal climates; Figure 5.9 (Page 86) indicates that these species are more likely to be found in the far northeast of the County. The close correlation of climatic variables with the main species variation is shown in Figure 6.18 (Page 159) and described in Section 6.4.3 (Page 158).

It therefore appears clear that the main floristic division has in part to do with geography, with many of the characteristic species for the human-influenced areas being species of the UK lowland, south and east, and species for the remainder being mainly species of the upland, north and west of the UK. It has been claimed that other midland counties occupy a north-south pivot location, for example Warwickshire (Falk, 2009), however the current study provides strong evidence for Edees' earlier view that Staffordshire's location between east and west and between north and south was important (Edees, 1972). A map showing suggested biogeographical regions is presented in Figure 7.1, produced in MapInfo by hand tracing and smoothing boundaries derived from Figure 5.7 (Page 78), with data from Figures 5.4 and 5.9 (Pages 68 and 86).

Figure 7.1 – Suggested biogeographical divisions of Staffordshire Vice-county



Further work on other taxonomic groups would help produce a more balanced view; Carey *et al.*, (Carey *et al.*, 1995) used birds, vascular plants, bryophytes and invertebrates to develop their biogeographical zonation of Scotland. They did not adopt a wider zonation for Scotland because it is highly oceanic and global zonations are not thought to work well in these situations (Tuckhanen, 1987), however they considered that this could be overcome with the model trained to recognise global zonations. The present study is therefore perhaps premature in using global zonations for Staffordshire without further comparative work, however it provides a first such zonation for the County, and represents a useful starting point from which further work can be undertaken.

In Montgomeryshire, plant distributions were found to be primarily divided between high and low altitude, with biogeography playing a secondary role; although oceanic and continental species groupings were easily demonstrated by coincidence mapping (Trueman *et al.*, 1995). In a study in Finland, Heikkinen and Birks (1996) found that differences in vegetation data over the 360 km^2 area of the Kevo nature reserve were connected to altitudinal variables, rather than to latitude or longitude. While Staffordshire is nearly ten times this size at 3090 km^2, it is not at the country scale mentioned by them as usually revealing a geographical variation. A study by Korvenpää *et al.,* in Finland covered 6800 km^2; their conclusion was that a shift to broader geographical gradients begins to occur at around that scale (Korvenpää *et al.*, 2003). Although alpine studies have found climate to be significant in floristic differences, for example in Austria (Moser *et al.*, 2005) and in Italy (Marini *et al.*, 2008); these are again very different situations to Staffordshire.

The present study does indicate that a biogeographic zonation applies in the County. Since it is clear that biogeographic zonation does apply across the UK then it is reasonable to suppose that the differences in the County reflect the wider ones, and that this is indeed due to the County's location as suggested by Edees (1972).

These biogeographic attributes show that Staffordshire was probably of interest before the industrial revolution, as a county occupying a transitional location. It is likely that semi-natural habitats were originally extensive, for example maps indicate that heathland occupied around 22,000 hectares in 1797 (Adams, 1990), compared to around 2000 hectares in 1989. It is likely that post-industrial changes and agricultural improvement had a synergistic effect, reducing semi-natural habitats and creating other habitats (for example brownfield land) and features (such as railways), meaning that the differences in plant distributions between upland and lowland Staffordshire became more emphatic.

One particular use of such biogeographical zones is in the monitoring of climate change. Transitional areas are by definition where one might expect to see the effects of external factors such as climate change. This in turn presents an argument for better resources for monitoring such areas. Carey *et al.* (Carey *et al.*, 1995) suggested the use of such zones and their characteristic species to identify species assemblages, and to assess priorities for conservation in Scotland. Central England probably does not occupy such a critical location for many species, and the zones in Staffordshire currently lack context, but it would be worth attempting if the present study could be expanded to a wider area.

7.2.3 Species richness

Plant species richness is another major characteristic that distinguishes certain areas of the County, separating agriculturally improved areas from both urban areas and the areas with semi-natural habitat. Species richness is clearly not only related to the non-intensive management of the semi-natural habitats, but it also seems to be a fundamental feature of the urban areas. Concentrations of species associated with arable farming are to some extent characteristic of the remaining species-poor areas, although the main distinguishing factor is simply the lack of diversity. Differentiation in species diversity can be discerned at a fine scale across most of the County; for example, the urban fringe is often clamed to be important in biodiversity terms (The Countryside Agency and Groundwork, 2005). The data confirms that in the Staffordshire Vice-county these areas have more surviving species of semi-natural habitat than the adjoining rural and central urban areas (Table 6.9, Page 173), although the 'urban fringe' here includes some quite central tetrads marked by the survival of significant post-industrial features.

Species-richness appears also to relate to habitat-richness; upland areas having a combination of grasslands, heathlands and wetlands, with the most species-rich of these areas probably having wetlands. The only slightly less species-rich urban areas have habitats associated with both post-industrial and residential situations as well as remnant semi-natural habitats; also often the scale of habitat differentiation is much smaller in urban areas (Young, 2001).

7.2.4 Urban species diversity

In Staffordshire, there is a strong overall correlation between species richness and urban areas, which is in line with findings in Europe (Pyšek, 1993)., and to some extent contradicts the conclusions of Roy *et al.,* (1999), who compared UK tetrads with a range of urban land cover. They found that species-richness was not affected by urban land, although concluding that the difference between their findings and those of Pyšek might be due to differences in sampling technique.

Urban areas in Staffordshire are characterised by species of remnant semi-natural habitats, post-industrial / brownfield land, gardens and cultivated land in gardens and allotments. Species richness in Berlin was greatest where these features coincided (Zerbe *et al.*, 2003), although allotments ('tenant gardens') appeared different to UK ones in having "…a great variety of fruit trees…" (p.144). In Rome soil moisture was correlated with species richness (Fanelli *et al.*, 2006). Even in the much damper climate of the English midlands, wetland and open water species did feature strongly in the most species rich areas, including urban ones, but possibly climatic differences between Rome and Staffordshire do not allow too close a comparison.

It is therefore reasonable to conclude that species richness in Staffordshire urban areas is greatest where semi-natural habitats, brownfield land, gardens, cultivated land and water coincide. To some extent, post-industrial land is often difficult to bring back into agriculture or to develop because of factores such as subsidence or contamination, meaning that habitats within these sites become protected. Other factors not included in the present study, such as proportion of wasteland, considered important for example in Paris (Muratet *et al.*, 2007), or age of development, important for example in Plzeň (Chocholoušková and Pyšek, 2003) and Plymouth (Kent *et al.*, 1999), may also be relevant, although difficult to characterise at the tetrad level. It is however interesting to note the important part played in urban plant diversity by species associated with disturbance and hence probably with the colonisation of wasteland; these habitats are now recognised in the UK Biodiversity Action Plan as Open Mosaic Habitat on Previously Developed Land (Biodiversity Reporting and Information Group, 2008).

In Staffordshire, the distinction between urban and arable areas can be traced in relative proportions of neophyte and annual preferential species (Pages 64 and 74). The human-influenced areas as a whole had a high proportion of annuals (47%), and a low proportion of neophytes (12%) in their preferentials compared to the core urban areas where 22% of preferential species are annuals and 58% are neophytes. This is consistent with the findings of Hill *et al.,* (2002) who considered that species of urban areas have medium levels of annuality, that there are high levels of neophytes associated, and recommended that these proportions could be used as measures of urbanity. Hill *et al.* made this recommendation having shown that non-urban arable species are included in lists of hemerobic species, making it difficult to apply the hemeroby scale of Kowarik (1990) to Britain. The converse appears to be more of a problem in the present study; the fact that so many arable species appear in urban areas making the arable areas difficult to characterise in species terms (Section 7.2.3, Page 181).

7.2.5 Importance of woodlands

After human influence and biogeography, woodland and hedges are the next most strongly distinguishing factor across the County. Although the areas of the County with semi-natural habitat have the highest proportion of woodland overall, parts of these areas are distinguished by having a higher proportion of woodland than others. Areas of woodland or shade-influenced land emerge from the human-influenced intensively managed parts of the County also; these to some extent characterise parts of the farmed lowlands, where hedges appear to play the significant role and may be the main repository of woodland species (Figure 5.8, Page 81; Table 5.6, Page 80). These areas are probably species and habitat poor, with hedges as the main repository of plant diversity, although it is possible that the scale of data has overlooked other factors such as ponds. Nature conservation effort in these lowland agricultural areas will therefore be most efficient if it concentrates on improving and enhancing the network of hedges and small copses.

A study by McCollin *et al.,* (2000a) compared woodland and hedge data and found that most ancient woodland species were not strongly associated with hedges, and that hedges do not provide habitat that is suitable for many woodland species. Some of the species listed in Table 5.6 coincide with the findings of McCollin *et al.,* who found that they were more usually found in hedges, such as *Stellaria holostea* and *Glechoma hederacea*. Many of the species in Table 5.6, such as *Mercurialis perennis, Veronica montana* and *Moehringia trinervia* are species that were more frequently found in woodlands according to McCollin *et al.* However these species are associated with parts of the County that have little woodland cover, and which are presumably therefore mainly confined to hedges, supporting the view that hedges in this part of Staffordshire are an important repository of woodland species.

7.2.6 Relationship of species to geology

The presence of limestone rock exposures distinguishes the northeast of the County from the remainder, and the botanical characteristics clearly reflect this (Section 5.4.4, Page 103 and Section 6.1.4, Page). Within this area the karst valleys are geologically less diverse and correspondingly less species-rich (Section 5.5.7, Page 118) than the Weaver Hills with their varied geology and soil types as described in Appendix D.1. Parts of Sedgley, Dudley and Walsall also have limestone exposures and characteristic limestone species; these were not distinct in Section 5, where presumably the overall urban characteristics mask the limestone ones. However, these areas were discernible in Section 6.1.4 (Page 143), demonstrating the high degree of distinctness of the limestone flora, although they were not as well defined as the Karst areas.

The relationship between geology and soil type and the heathland areas of the County can also be distinguished from the analyses and confirmed by the correlation with the Sherwood Triassic geology in Section 6.4.5 (Page 169). These areas are the urban fringes of the Black Country (Appendix D.8), the Cannock area (Appendix D.5) and around Stoke (Appendix D.2), and in the rural semi-natural areas including Staffordshire Moorlands and Cannock Chase. A third heathy component is found in the west of the County around Burnt Wood, around the edges of Cannock Chase and encompassing most of the land between Stoke and Leek. This last heathy constituent appears to be more fragmented than the core areas with fewer typical species, but the fact that the species survive, and the confirmation from the Sherwood Triassic variable, indicates that suitable thin soils are found in these areas. These might be where heathland habitat creation or restoration can be more readily achieved; for example, it includes the sand and gravel quarrying area around Cheadle where restoration opportunities are likely to arise.

7.3 Ecological characteristics

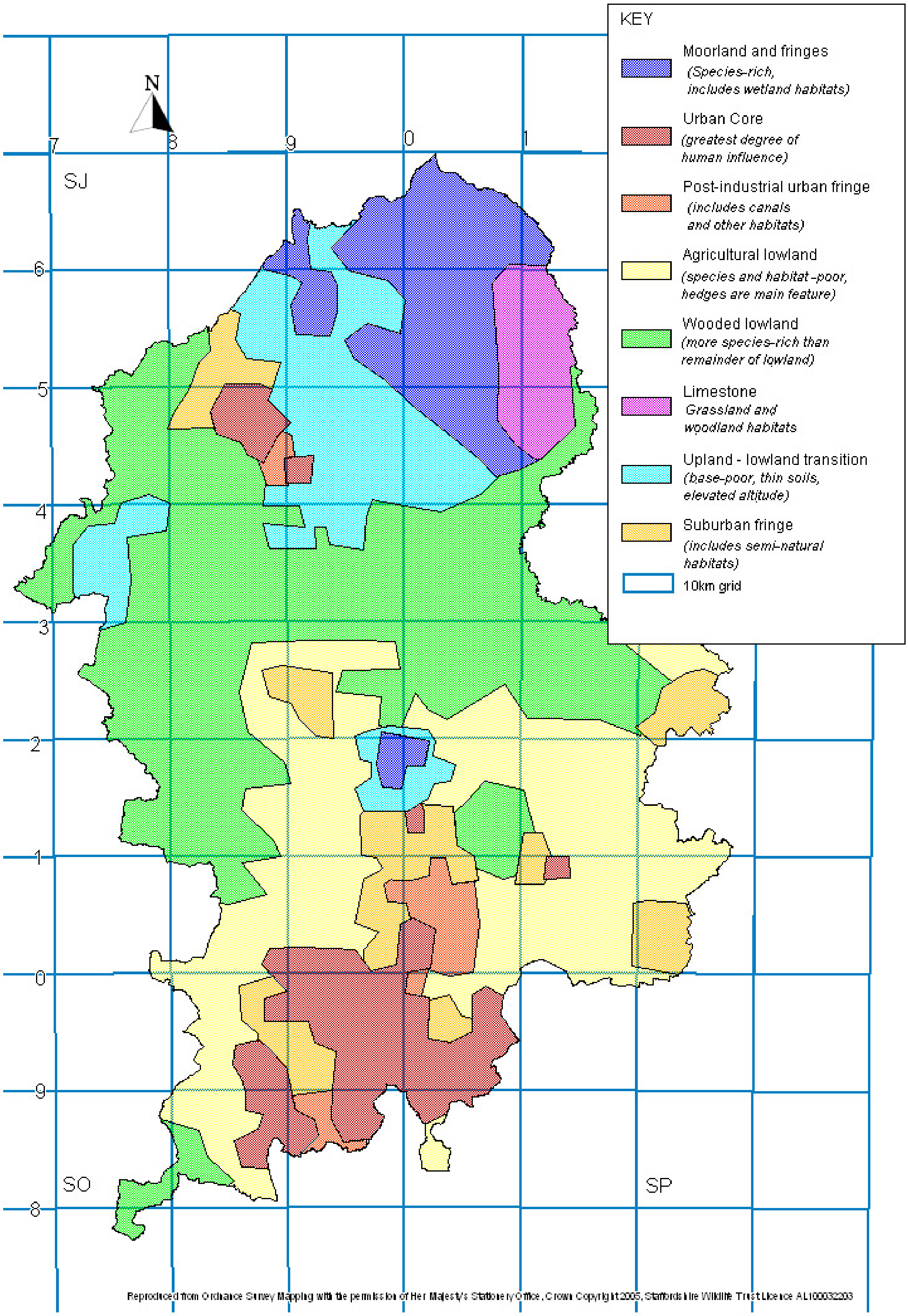
Figure 7.2 combines the conclusions outlined in Section 7.2 and in Table 6.9 (Page 173) and Figure 5.10 (Page 92). In an attempt to produce reasonably smooth boundaries, it was produced by hand tracing in MapInfo, and therefore lacks some of the detail of Figure 5.10. The resulting categories are related to human influence, plant biodiversity, geography, climate and geology. Most categories encompass several habitat types. This is the first characterisation of the County using comprehensive biological data.

Few studies go right across urban and rural areas, habitat-rich and habitat-poor areas. In their examination of Montgomeryshire, Trueman *et al.,* (1995) produced a floristic analysis of the whole County, which includes urban areas with industrial history (Newtown and Llanidloes are both former woollen mill towns). The Montgomeryshire study separated upland and lowland areas, but did not bring out urban areas or indicator species, probably because the towns are small in extent (Newtown is 5km^2, compared to Stafford at 21km^2).

However, most studies concentrate on entirely rural areas, e.g. agricultural landscapes in Norway (Bär and Löffler, 2007), Kevo, North Finland (Heikkinen and Birks, 1996) or entirely urban areas, such as Plymouth (Kent *et al.*, 1999). Some concentrate on particular habitat types, for example forest species analysis in Switzerland (Wohlgemuth *et al.*, 2008a). In some cases comparison is made between different areas, for example urban and suburban Rome (Fanelli *et al.*, 2006), which to some extent presupposes that differences exist. All of these studies exclude the possibility of examining the transitional areas that are often the most interesting in ecological terms.

As stated above, few studies incorporate both urban and rural areas to this extent so it was not possible to predict that data at this scale would detect such information. The present study tested the use of comprehensive species lists, rather than removing very common and / or very rare taxa, as in Montgomeryshire (Trueman *et al.*, 1995), and used some partial tetrads (over 1 km^2). The study demonstrates a remarkably robust technique, capable of producing a credible characterisation of a county or similar area, using data that is for the most part readily available. Characterisation of a region can be invaluable in targeting nature conservation resources, particularly in ensuring that the most appropriate habitats are created in each area. The current trend is for Biodiversity Action Plans to move to area-based approaches, for which characterisation is an essential component.

Figure 7.2 – Ecological characteristion of Staffordshire, based on plant distributions



7.4 Groups of species with similar ecological requirements

Section 2.7.2 outlines the concept of axiophyte species, and suggests that the current study could be used to generate an alternative list for Staffordshire, based on objective data. The Botanical Society for the British Isles criteria for axiophytes (Botanical Society for the British Isles, 2010, projects, axiophytes) are:

> Species that are 90% restricted to habitats of conservation importance
>
> Species recorded in fewer than 25% of tetrads in a county
>
> Species that are known from at least three sites in the county

As an attempt to define the first criterion, axiophyte species should provide a measure of ecological quality and be 90% confined to habitats which have at least some of the following characteristics: long-established, relatively stable, subject to extensive, consistent, management, operate at low soil fertility (NPK). Appendix E lists axiophyte species for Staffordshire, with suggested amendments based on the indicator species for the 'habitat-rich groups' (1, 01, 10, 11, 001, 101, 111) identified by indicator species analysis (Sections 5.2 to 5.4). This process identified potential species to add to the list for Staffordshire as detailed in Table 7.1 below, and highlighted in the Appendix in green and grey.

The following species occur in less than 25% of tetrads and would appear to be good potential new axiophytes: *Cruciata laevipes, Dactylorhiza praetermissa Dactylorhiza* x *grandis, Euphrasia species, Hieracium acuminatum, Knautia arvensis, Polypodium vulgare, Potentilla* x *mixta, Rosa caesia* and *Rosa* x *dumalis*. All of these suggested species are currently on one or other county axiophyte list (Botanical Society for the British Isles, 2010), except *Euphrasia* species, although present as *Euphrasia officinalis* agg, and *Rosa caesia* (segregates are on the list).

The analysis identified a number of rare species already on the Staffordshire list such as *Potentilla neumanniana* that occur in specific habitats and corresponding small end groups such as limestone areas. The process did not select the rare but more widely distributed species, such as *Calamagrostis canescens*, probably because their wide distribution means they are scattered across several end groups. Further consultation and examination of the data are needed before the revised list can be used, however the present study provides support for nearly 50% of the existing list, and offers an additional 37 species.

Closer examination of the remaining 171 species on the present list appears to justify the removal of around 70 species that are poor indicators of semi-natural habitat. This leaves 101 probable axiophytes that were not confirmed by the analysis. 77 of these are rare, found in 5% or fewer tetrads, however rare species are expected to be difficult to detect using the analyses, and will usually require 'selection by expert opinion'. The remaining 24 species on the current list are probably good axiophytes that the analysis 'should' have picked up but did not do so. They include *Carex disticha, Carex paniculata, Euonymus europaeus* and Sanguisorba *officinalis*, these are mainly wetland species, and it is possible that these were not picked up by the analysis because there is no 'entirely wetland' end group.

Table 7.1 – Possible amendments to axiophyte list for Staffordshire

Additions suggested by indicator species analysis	**No of species**
Potential indicators of good habitat	10
Potential indicators of good habitat in between 25% and 50% of tetrads	27
Total new suggested	37
Indicators of good habitat but somewhat frequent	1
Possibly include species	2
Reject - too frequent	16
Poor indicators of semi-natural habitat - reject	31
Current list	
Confirmed as good indicators of important habitats by analysis	167
Species not confined to primary habitats, or otherwise not a good indicator	70
Indicator of important habitat not detected by analysis	101
Total current	338

The present study has demonstrated an objective way of selecting axiophytes, which could be applied in any region with similar data. Clearly some discrepancy is likely between lists produced by county experts and those produced in this way. Therefore, this technique is not suggested as an alternative, but a way of complementing, cross-checking and validating lists produced by experts.

The analysis could also be used to produce lists of species that are good indicators of other situations, such as urban areas. This would be very helpful for urban areas across the UK, with the recent addition of the Biodiversity Action Plan habitat 'open mosaic habitat on previously developed land', which is at present poorly defined (Biodiversity Reporting and Information Group, 2008).

Using indicator species as described could reduce the amount of data required for effective monitoring, which would be invaluable for strategic processes, such as Biodiversity Action Plans (UK Biodiversity Partnership Standing Committee, 2007); (Smith, 2002).

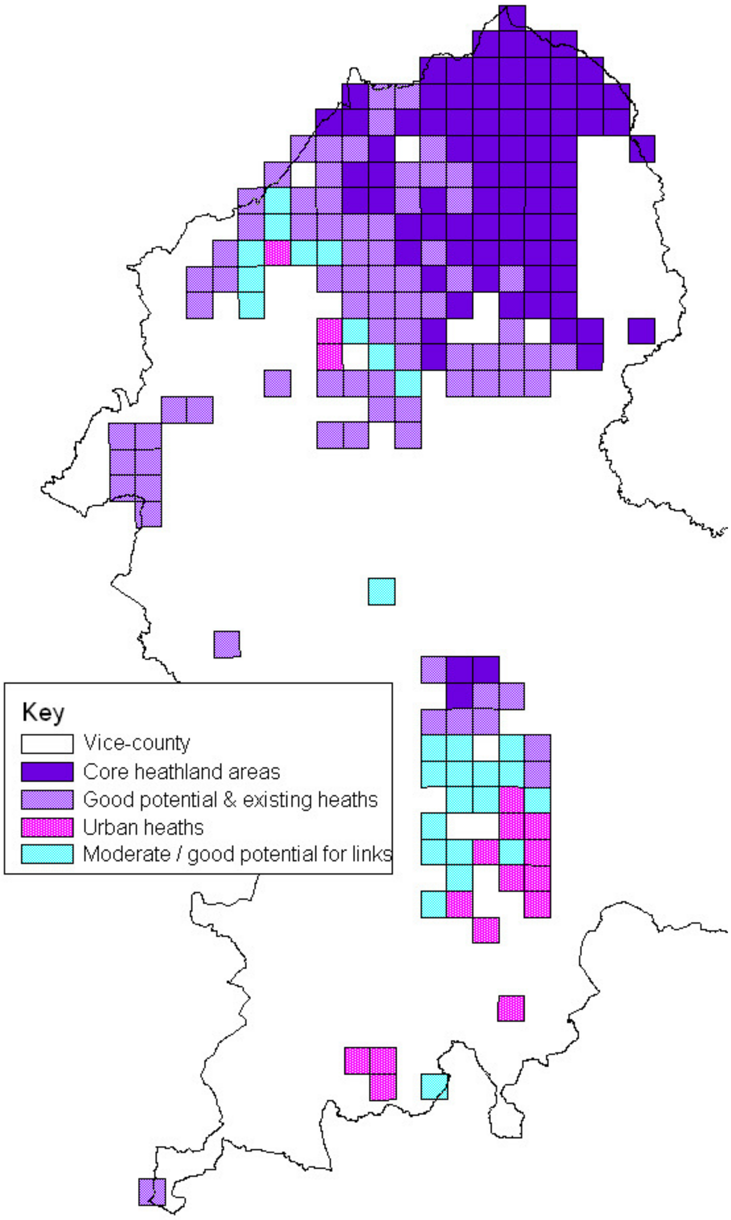
7.5 Effective use of nature conservation resources

7.5.1 Habitat creation and restoration

The study has the potential to identify areas that may be suitable for habitat restoration or creation. For example, potential habitat creation areas for heathland were identified in remnant heathland areas (Section 7.2.6). These are shown in Figure 7.3, which is based on the indicator species analysis, with heathland areas also highlighted by the analysis, indicating how these areas might link. This also has potential to help show how animal species; for example, specialist heathland invertebrates might be enabled to reach new territories. Field research would be needed in both cases, however the information provided could be used to focus efforts. The southwestern heaths (Appendix D.7) are not shown on the diagram because they do not emerge strongly from any of the analyses carried out (Section 5.4.2.2), so the figure would need to be supplemented with other information.

Additionally, the clear highlighting of the County's only limestone area in the analyses suggests that for other counties the technique could identify different habitat creation opportunities based on other physical characteristics and plant distributions.

Figure 7.3 – Heathland and potential for heathland creation

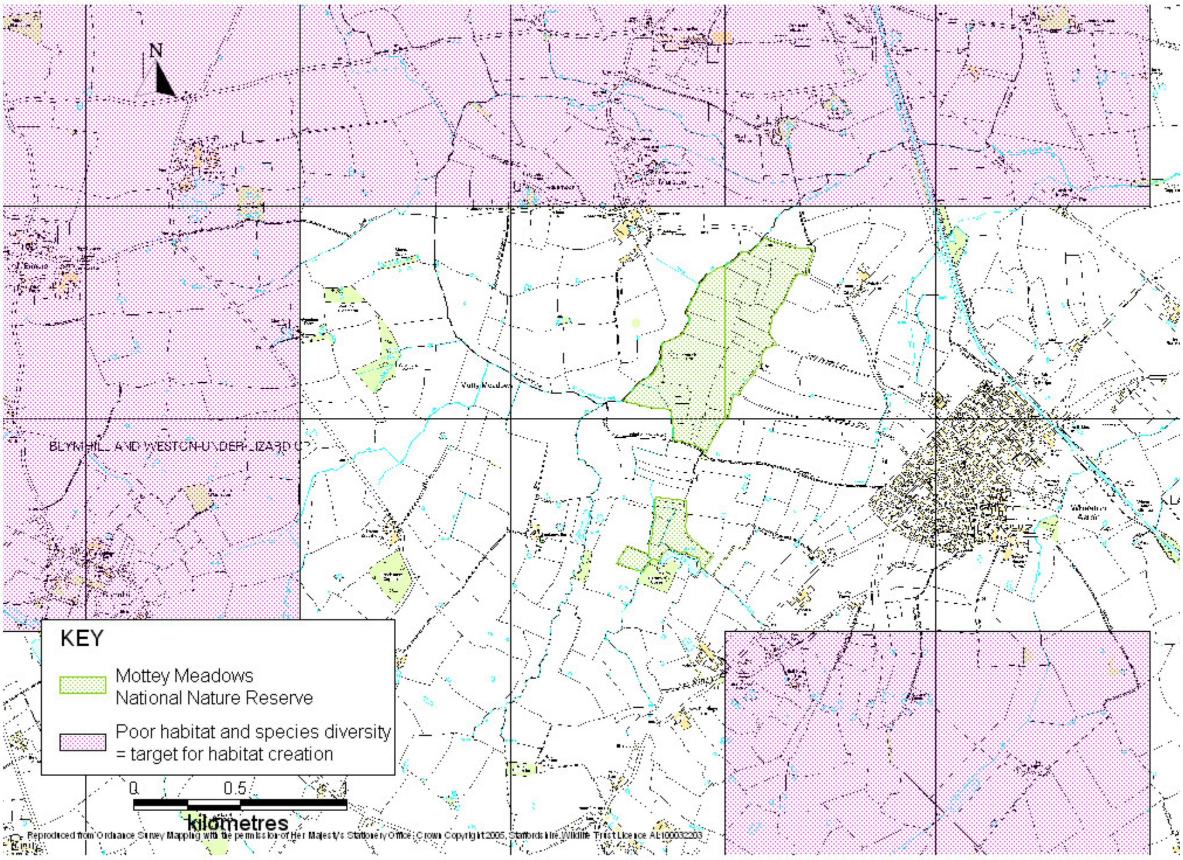


7.5.2 Other targeting

Chapters 5 and 6 also identified areas of the County that are species and habitat poor. With growing concerns about food security and increasing pressure on funding streams, it is unrealistic to expect all of these areas to become habitat rich, and careful targeting and effective use of resources are vital. However, among these poor areas are important sites that need to be protected and linked to other semi-natural habitats if they are to withstand the effects of change, including climate change. Figure 7.4 shows the poor setting of Mottey Meadows National Nature Reserve (NNR) (Appendix D.3), and emphasises the need for habitat creation and enhancement where important sites like this are isolated in the landscape.

This approach could be used to good effect by any body that wishes to apply for a grant for habitat creation work (e.g. local authorities, wildlife charities), and many funding bodies would welcome the use of a sound scientific basis as justification. Grant giving bodies, such as landfill operators or Natural England could also use similar data to help target grants, for example agri-environment schemes.

Figure 7.4 – Mottey Meadows NNR and surrounding poor tetrads



7.5.3 Survey targeting

Tetrads that behave atypically in analysis, compared to geographically close tetrads, are potentially of interest. For example, Figure 7.5 (a version of Figure 6.3, Page 137 with different tetrad symbols) shows lowland tetrads with known nature conservation importance appearing after analysis with upland habitat-rich tetrads. Taking these known lowland SSSIs as 'markers', it might be expected that the nearby lowland tetrads on the diagram are to some degree similar in plant diversity terms. These nearby tetrads therefore have potential for previously unknown habitats or species of importance – 'tetrads with high potential'. A search area for these 'tetrads with high potential', based on the 'marker tetrads' is shown outlined with a green polygon.

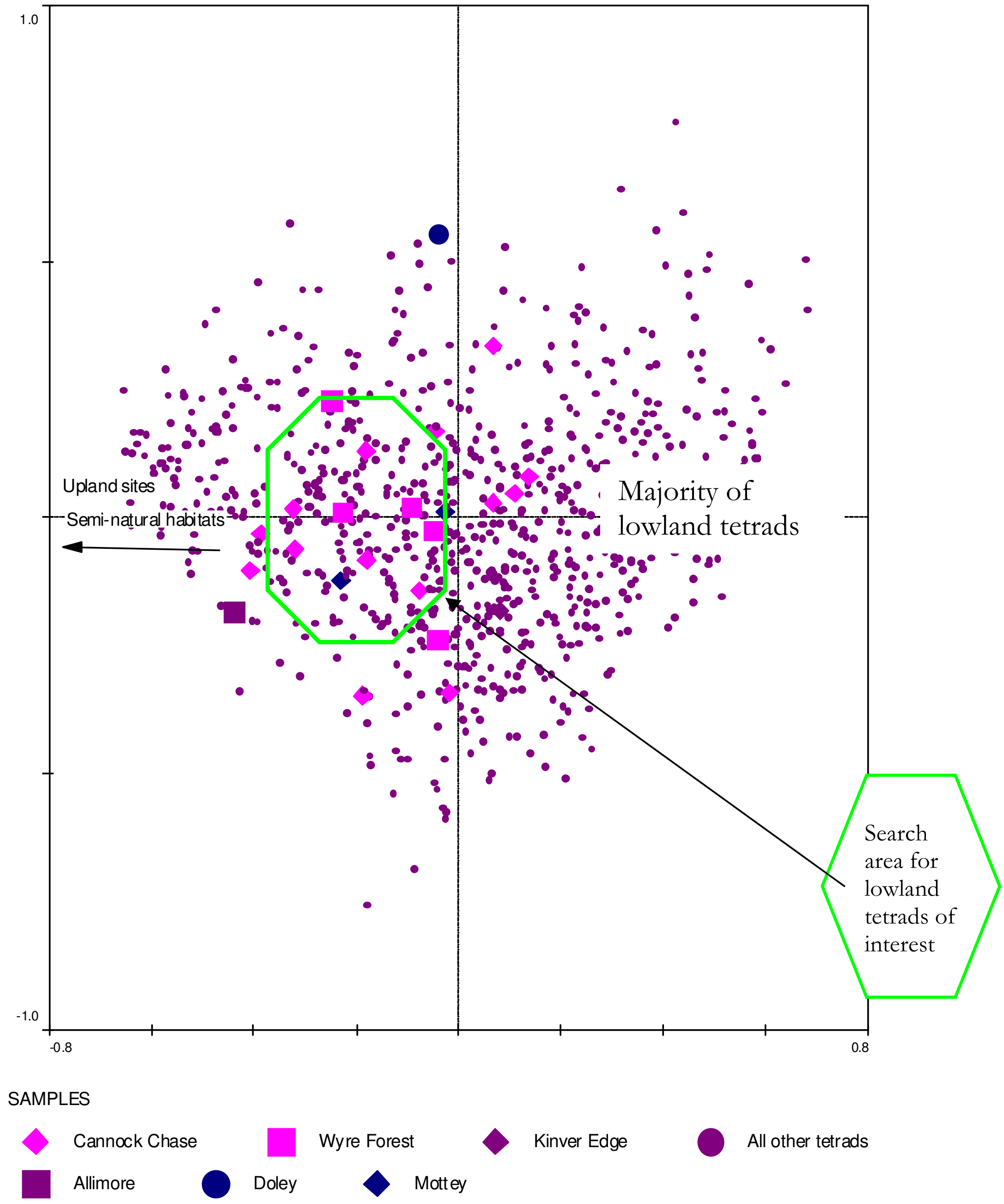
Another way of tackling the 'high potential' issue is demonstrated in Figure 7.6 (derived from the same PCA as Figure 7.5), which shows a section of the County with 'habitat-rich' tetrads mapped together with designated nature conservation sites (in green). The highlighted tetrads are areas that should be targeted for survey, since they fall among tetrads that clearly have importance for nature conservation, but do not themselves contain designated sites. Section 5.5.4 (Page 119) also identified a similar (probably overlapping) group of tetrads that should be examined in the same way for potential survey target areas.

Surveys in the County (Cadman *et al.*, 2004 - present) continue to discover new sites for designation, at least as Sites of County Biological Importance (SBI), with several recent sites of equivalent quality to Sites of Special Scientific Interest. This confirms that coverage is not comprehensive, probably because survey work is poorly resourced.

The situation in other counties is often worse; a recent report for the West Midlands (Tucker, 2009) confirmed Staffordshire's system as the most up-to-date of the six 'counties' in the Region. The other counties have recent plant data at least at the tetrad scale, and this approach could be used to target their future survey work.

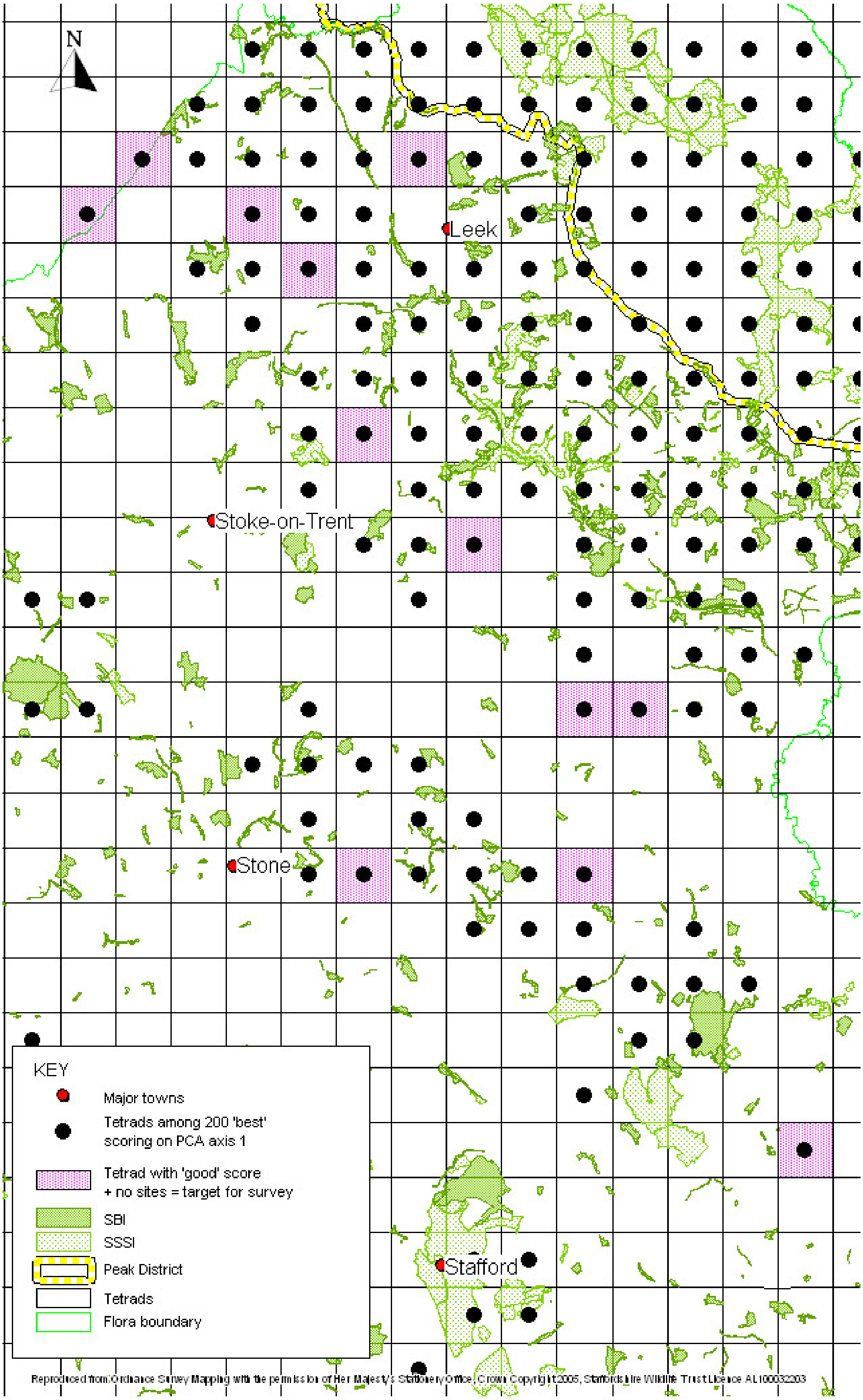
There have also been concerns that the inconsistency of this SBI data leads to difficulties in devising defensible strategies for working at a landscape scale across county boundaries. Tetrad data from across several counties could be analysed in this way in one block (or several intersecting blocks) to provide evidence for landscape scale work. The tetrad data would need to be corrected for differences in recording effort (Prendergast *et al.*, 1993), but would certainly more be more consistent and more up-to-date overall than site-based data.

Figure 7.5 – 'Marker' lowland SSSIs and search area for 'tetrads of high potential'



This PCA was performed on 813 samples. It is based on a covariance matrix (species are centred only and weighted by their variance). The scaling focus on symmetric correlation and the scores are not transformed after axes extraction so the length of arrow reflects the standard deviation of species; $\lambda 1 = 8.7\%$ of species variance; $\lambda 1 + \lambda 2 = 13.5\%$ of species variance

Figure 7.6 - Tetrads with good potential but no current sites



7.5.4 Measuring biodiversity change

Many studies model species-richness as a key indicator of biodiversity (Wohlgemuth *et al.*, 2008b; Heikkinen and Neuvonen, 1997; Parviainen *et al.*, 2010). However, plant species-richness does not always correlate with habitat quality; acidic woodland for example contains a limited range of plant species. The present study has used all available plant data to provide a profile of the County, which has been a first step towards establishing a detailed baseline model against which to measure biodiversity change. It may be many years before another large dataset is collected, however data based on sample tetrads as described for the BSBI monitoring scheme (Le Duc *et al.*, 1992), could be gathered and compared to the complete County model provided here.

This technique can be translated to any county with similar tetrad scale data. It may even be possible to produce a broad profile of the entire UK based on tetrad monitoring scheme of the BSBI (Braithwaite *et al.*, 2006), although the tetrads are widely spaced and any analysis would be likely to miss anything but the most obvious trends.

In terms of biodiversity monitoring it would be most helpful to have a system that could deal with a range of plant and animal species. The approach of Carey *et al.* (Carey *et al.*, 1995) in their biogeographical classification of Scotland could be used to produce an ecological classification using a range of taxa and a parallel series of analyses along the lines of the present study.

7.6 Limitations

7.6.1 Scale

A potential problem with a study such as the present one is one of scale; because the tetrad resolution will inevitably mask some of the fine detail. For example, Vanderpoorten *et al.,* (2005) concluded that although spruce reduces bryophyte diversity locally, at the large scale used in their study in Belgium (4 km x 4 km) the presence of spruce plantations increased landscape heterogeneity and with it bryophyte diversity. In Finland, Heikkinen *et al.* (1998), considered that a monad scale sample did not pick up ecological variation in the most heterogenous areas. In Staffordshire, it is probable that the scale used has meant that some detail has been lost - the lack of apparent wetland species assemblages in the analyses, for example. However, the techniques used do not focus on species-richness alone, and the examination of groups of indicator species with spatial interpretation has revealed several important gradients in plant species distributions.

Local Records Centres find tetrad data too coarse for most applications (C Slawson pers. comm.). Ideally, data would be collected at least at the monad scale, which would be likely to reveal more subtleties than tetrad data. Data processing at this scale for an entire county would probably present a considerable challenge, however, because there are currently size limitations on spreadsheets that are needed for producing data for WCanoImp (Section 4.1, Page 56). It is also possible that data with a finer level of detail could mask some of the wider trends highlighted in the present study. Monad records are being used for the 'Flora of Birmingham and the Black Country' (Trueman *et al.*, in prep), where the higher degree of habitat diversity is considered to render the finer scale of recording more informative (I.C. Trueman pers. comm.).

7.6.2 Data analysis techniques

With TWINSPAN a large dataset of binary species data (presence / absence only) such as the one in the present study does not produce large eigenvalues. Therefore, the use of CANOCO was helpful in showing the strong separation of TWINSPAN end groups. CANOCO alone can be difficult to read, especially after the first axis has been examined, and a combination of the techniques has therefore been invaluable in dealing with the data for the present study. Ideally, recorders would produce some measure of the frequency of each species within the recording unit, as in 'A Computer Mapped Flora – A Study of the County of Warwickshire' (Cadbury *et al.*, 1971), which would then enable more detailed analysis.

The data could be used to produce a model by selecting a stratified sample of tetrads (training set), and then testing the model against the remaining tetrads (test set), for example Heikkinen and Neuvonen's 1997 study (1997) of a Finnish nature reserve, using Generalised Linear Modelling (GLM). A similar approach was used by Wohlegemuth *et al.* (2008b) to model species richness in sample monads across Switzerland.

7.6.3 Environmental variables

Time taken on extracting variables from maps could be reduced by using vector data, although this does not distinguish between certain land uses, canals and other open water, for example, or allotments and other open land in towns. Aerial photographs enable better interpretation, but this data still has to be captured. In some cases, such as the assessment of average field size, use of vector data would be likely to introduce many errors because of the difficulty in separating field parcels from other land parcels, such as gardens.

The current study uses the method suggested by Blanchet *et al.,* to identify collinear variables (Blanchet *et al.*, 2008). The data are clearly multicollinear, which affects the overall statistical significance of tests that are commonly used (Mac Nally, 2000; Mac Nally, 2002; Heikkinen, 1996; Blanchet *et al.*, 2008). Most work on mesoscale data with datasets of explanatory variables has been done with the intention of creating a model, either for wider use, or to predict future changes in the same area. These models are most often used to model species richness, whereas the purpose of the present study is to examine relationships within the flora.

While it might be reasonable to expect a small set of variables to be useful in modelling one trend, it is reasonable to expect that more, or different, variables would be needed to explain different trends. The different types of variable used all helped to interpret the floristic data and would suggest that if the problem of multicollinearity can be dealt with it is worth maintaining a wide set of environmental variables in studies of this type.

One factor that has not been confirmed through use of environmental variables is the importance of hedges, particularly in the lowland areas. Maps do not distinguish between hedges, fences and drystone walls, and these are difficult to tell apart on aerial photographs because of shadows and because fence lines often have weeds that can appear similar to hedge plants at the resolution available. Remote sensing has been used by many, for example (Gould, 2000; Luoto *et al.*, 2001). The quality of data makes it possible to separate different species of street tree, for example, with considerable accuracy (Xiao *et al.*, 2004), so it would be worth investigating whether remote sensing data can be used to improve environmental data, particularly with respect to hedges.

8 CONCLUSIONS

8.1 Ecological characterisation

The present study has demonstrated the use of mesoscale vascular plant data to characterise and classify the Staffordshire region in terms of its biodiversity importance, as it set out to do (Section 1.3.2, page 5). By suggesting relatively straightforward methods of understanding large data sets of species distributions this has overcome the limitations suggested by Hill (2003, p328) that *"…distributional data from local floras remain rather intractable and difficult to use."*. Data analysis therefore improved understanding of the biodiversity importance of the spatial units, which were then characterised by producing an ecological classification of the County.

The 2 km x 2 km recording unit was effective in detecting five major influences on plant distribution:

- Human influence
- Habitat quality and richness
- Topography (and to a lesser degree latitude)
- Presence of woodlands or hedges
- Underlying solid geology

The most important of the relationships between plant distributions and the physical and social geography and geology of the Staffordshire region is with human geography. However, the present study has also emphasised the importance of the physical geography of the County. The relevance of geology to plant distributions in the County, particularly Limestone exposures and Sherwood Triassic are described.

Environmental factors relating to physical and human geography, such as built development and transport infrastructure are closely correlated with plant distribution; related factors include those of geology, climate and soils. Other important environmental factors relate to field size and historic field pattern, and to natural features such as woodlands and hedges.

Objective analysis of a wide range of data facilitated the selection of indicator species for a range of purposes. An example has been developed using axiophyte species to demonstrate how the analyses can help achieve selection of indicator species lists, with suggestions for further work.

The study has made it possible to generate objective data for targeting nature conservation activity in terms of habitat creation, survey efforts and the targeting of funding. The techniques developed could also help produce objective strategies across wider areas, such as Regions.

The original aims and objectives for the study have therefore been met in full; wider applications and limitations of the present study are covered in the following sections.

8.2 Wider applications

The discussion outlines several areas where this technique could be applied to produce spatial ecological information, or to target nature conservation resources more effective, which include:

- Habitat creation targeting
- Production of nature conservation strategies
- The Biodiversity Action Plan process
- Targeting of grant aid for this work, such as Landfill Tax
- Targeting of agri-environment schemes

The study also demonstrated that it is possible to link analysis of botanical data with non-ecological disciplines by showing a link between plant distribution and historic field patterns. A similar link with climatic data was also demonstrated, which could be used for long-term monitoring and expanded to cover larger areas.

The current study has also demonstrated the selection of lists of critical species for use in development of strategies or monitoring. The use of small groups of species to model wider envronmental change is attractive because the resources required to collect large-scale environmental data are rarely available.

Using analysis to establish which species to monitor is likely to produce more defensible information than the selection of species based on subjective judgement, although expert opinion is required to complement this approach. The use of defensible methodologies is also more likely to attract funding for all of the applications mentioned.

8.3 Possible further work

There is a considerable body of historic plant distribution data for Staffordshire (Edees unpublished; Section 2.2.2.5, Page 18) and discrepancies in recording effort between this and the present data have been examined in detail (J Hawksford, I Hopkins pers. comms.). Comparison with this historic data should be possible after making suitable allowance for these discrepancies, and has the potential to provide considerable insights into changes in the County, as well as providing a basis for future comparisons. Similar studies have already been produced for Britain (Braithwaite *et al.*, 2006), and for Northamptonshire (McCollin *et al.*, 2000b), while Telfer *et al.,* (Telfer *et al.*, 2002) provide a suitable methodology for correcting for discrepancies.

The success of the analysis of mesoscale data for counties, as in 'The Flora of Montgomeryshire' (Trueman *et al.*, 1995), and in the present study indicates that the anlysis of an entire region is possible. Discrepancies would need to be reduced, but efforts would enable the production of strategies, such as described in 'Landscapes for Living' (West Midlands Biodiversity Partnership, 2008), which promotes biodiversity work across the West Midlands Region.

Monitoring schemes, (Rich and Woodruff, 1990; Le Duc *et al.*, 1992) could be used to estimate the probability of finding species in other areas of the country. An analysis of information within a county, such as the present study, could be used to further inform this type of work by providing additional details about species and how they behave in a transitional area. For example, analysis can provide insights into individual species, Section 6.1.1 appears to confirm that *Calystegia silvatica,* as a relatively new species, has replaced *Calystegia sepium* in urban areas (Hill *et al.*, 2002).

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APPENDIX A - SPECIES EDITING & ABBREVIATIONS

NB Species listed in alphabetical order of their abbreviations

Species	Abbreviation	Notes on editing process
Abies alba	Abiealba	
Abies amabilis		Record deleted – arboretum single record
Abies grandis	Abiegran	
Abies nordmanniana	Abienord	
Abies procera	Abieproc	
Acanthus mollis	Acanmoll	
Acanthus spinosus	Acanspin	
Acer campestre	Acercamp	
Acer cappadocicum	Acercapp	
Acer griseum	Acergris	
Acer japonicum	Acerjapo	
Acer negundo	Acernegu	
Acer palmatum	Acerpalm	
Acer platanoides	Acerplat	
Acer pseudoplatanus	Acerpseu	Includes cultivars such as Purpureum group
Acer rufinerve		Record deleted – arboretum single record
Acer rubrum		Record deleted – arboretum single record
Acer saccharinum	Acersacc	
Achillea filipendulina	Achifili	
Achillea millefolium	Achimill	
Achillea ptarmica	Achiptar	
Aconitum lycoctonum ssp. vulparia	Aconlyco	
Aconitum napellus agg.	Aconnape	Includes A. napellus ssp. napellus
Aconitum napellus x variegatum (A. x cammarum)	Aconxcam	
Acorus calamus	Acorcala	
Adonis annua	Adonannu	
Adoxa moschatellina	Adoxmosc	
Aegopodium podagraria	Aegopoda	
Aesculus carnea	Aesccarn	
Aesculus hippocastanum	Aeschipp	
Aesculus parviflora		Record deleted – arboretum single record
Aethusa cynapium	Aethcyna	
Ageratum houstonianum	Agerhous	
Agrimonia eupatoria	Agrieupa	
Agrimonia procera	Agriproc	
Agrostemma githago	Agrogith	
Agrostis canina sens.lat.	AgrocaSL	Includes A. canina agg.and A. canina sens str
Agrostis capillaris	Agrocapi	
Agrostis gigantea	Agrogiga	
Agrostis x murbeckii (A capillaries x stolonifera)	Agroxmur	
Agrostis stolonifera	Agrostol	
Agrostis vinealis	Agrovine	
Ailanthus altissima	Ailaalti	
Aira caryophyllea	Airacary	
Aira praecox	Airaprae	
Ajuga reptans	Ajugrept	
Akebia quinata	Akebquin	
Alcea rosea	Alcerose	
Alchemilla alpina	Alchalpi	
Alchemilla conjuncta	Alchconj	
Alchemilla filicaulis	Alchfili	Includes ssp. vestita
Alchemilla glabra	Alchglab	
Alchemilla mollis	Alchmoll	
Alchemilla vulgaris agg.	Alchvulg	Deleted
Alchemilla xanthochlora	Alchxant	

Alisma gramineum	Alisgram	
Alisma lanceolatum	Alislanc	
Alisma plantago-aquatica	Alisplan	
Alliaria petiolata	Allipeti	
Allium carinatum	Allicari	
Allium cepa	Allicepa	
Allium moly	Allimoly	
Allium paradoxum	Allipara	
Allium porrum	Alliporr	
Allium roseum	Allirose	
Allium schoenoprasum	Allischo	
Allium sphaerocephalon	Allispha	
Allium triquetrum	Allitriq	
Allium tuberosum	Allitube	
Allium ursinum	Alliursi	
Allium vineale	Allivine	Includes ssp.vineale
Alnus cordata	Alnucord	
Alnus glutinosa	Alnuglut	
Alnus x pubescens (glutinosa x incana)	Alnuxpub	
Alnus incana	Alnuinca	
Alnus rubra	Alnurubr	
Alopecurus aequalis	Alopaequ	
Alopecurus geniculatus	Alopgeni	
Alopecurus myosuroides	Alopmyos	
Alopecurus pratensis	Alopprat	
Alstroemeria aurea	Alstaure	
Alyssum saxatile	Alyssaxa	
Amaranthus albus	Amaralbu	
Amaranthus bouchonii	Amarbouc	
Amaranthus caudatus	Amarcaud	
Amaranthus hybridus	Amarhybr	
Amaranthus retroflexus	Amarretr	
Ambrosia artemisiifolia	Ambrarte	
Amelanchier lamarckii	Amellama	
Ammi majus	Ammimaju	
Ammi visnaga	Ammivisn	
Amsinkia lycopsoides	Amsilyco	
Amsinckia micrantha	Amsimicr	
Anacamptis pyramidalis	Anacpyra	
Anagallis arvensis	Anagarve	Includes ssp. arvensis
Anagallis arvensis ssp. foemina	AnagaSSf	
Anagallis tenella	Anagtene	
Anaphalis margaritacea	Anapmarg	
Anchusa arvensis	Ancharve	
Anchusa azurea	Anchazur	
Andromeda polifolia	Andrpoli	
Anemone apennina	Anemapen	
Anemone blanda	Anemblan	
Anemone x hybrida (A hupehensis x vitifolia.)	Anemhupe	
Anemone nemorosa	Anemnemo	
Anethum graveolens	Anetgrav	
Angelica archangelica	Angearch	
Angelica sylvestris	Angesylv	
Anisantha diandra	Anisdian	
Anisantha rigida	Anisrigi	
Anisantha sterilis	Anisster	
Anthemis arvensis	Antharve	
Anthemis cotula	Anthcotu	
Anthemis tinctoria	Anthtinc	
Anthoxanthum odoratum	Anthodor	
Anthriscus caucalis	Anthcauc	
Anthriscus sylvestris	Anthsylv	
Anthyllis vulneraria	Anthvuln	
Anthyllis vulneraria ssp. polyphylla	AnthvSSp	

Antirrhinum majus	Antimaju	
Apera interrupta	Aperinte	
Apera spica-venti	Aperspic	
Aphanes arvensis agg.	Aphaarve	Includes Aphanes arvensis sens.str.
Aphanes australis	Aphaaust	
Apium graveolens	Apiugrav	
Apium inundatum	Apiuinun	
Apium nodiflorum	Apiunodi	
Aquilegia vulgaris	Aquivulg	
Arabidopsis thaliana	Arabthal	
Arabis caucasica	Arabcauc	
Arabis hirsuta	Arabhirs	
Araucaria araucana	Arauarau	
Arctium lappa	Arctlapp	
Arctium minus agg		Deleted
Arctium minus ssp. minus	Arctminu	
Arctium minus ssp. nemorosum	Arctnemo	
Arenaria serpyllifolia sens. lat.	Arenserp	Includes ssp. leptoclados & ssp. serpyllifolia
Argemone mexicana	Argemexi	
Armeria maritima	Armemari	
Armoracia rusticana	Armorust	
Arrhenatherum elatius	Arrhelat	
Artemisia absinthium	Arteabsi	
Artemisia dracunculus	Artedrac	
Artemisia vulgaris	Artevulg	
Arum italicum	Arumital	Includes ssp. italicum & ssp. neglectum
Arum maculatum	Arummacu	
Aruncus dioicus	Arundioi	
Asparagus officinalis	Aspaoffi	
Asplenium adiantum-nigrum	Aspladia	
Asplenium ruta-muraria	Asplruta	
Asplenium trichomanes	Aspltric	
Aster laevis x novi-belgii (A. x versicolor)	Astelaev	
Aster lanceolatus	Astelanc	
Aster x salignus (A lanceolatus x novi-belgii)	Astexsal	
Aster novi-belgii	Astenovi	
Aster tripolium	Astetrip	
Astragalus glycyphyllos	Astrglyc	
Astragalus odoratus	Astrodor	
Athyrium filix-femina	Athyfili	
Atriplex hortensis	Atrihort	
Atriplex littoralis	Atrilitt	
Atriplex patula	Atripatu	
Atriplex prostrata	Atripros	
Atropa belladonna	Atrobell	
Aubrieta deltoidea	Aubrdelt	
Aucuba japonica	Aucujapo	
Avena fatua	Avenfatu	
Avena sativa	Avensati	
Avena sterilis ssp. ludoviciana	Avenster	
Azolla filiculoides	Azolfili	
Ballota nigra	Ballnigr	
Barbarea intermedia	Barbinte	
Barbarea stricta	Barbstri	
Barbarea verna	Barbvern	
Barbarea vulgaris	Barbvulg	
Bassia scoparia	Bassscop	
Bellis perennis	Bellpere	
Berberis aggregata	Berbaggr	
Berberis darwinii	Berbdarw	
Berberis x stenophylla (B darwinii x empetrifolia)	Berbxste	
Berberis gagnepainii	Berbgagn	
Berberis julianae	Berbjuli	
Berberis thunbergii	Berbthun	

Berberis vulgaris	Berbvulg	
Berberis wilsoniae	Berbwils	
Berberis x frikartii	Berbxfri	
Bergenia crassifolia	Bergcras	
Berula erecta	Beruerec	
Beta vulgaris	Betavulg	Includes ssp.cicla & ssp.vulgaris
Betula papyrifera	Betupapy	
Betula pendula	Betupend	
Betula pendula 'laciniata'		Record deleted – arboretum single record
Betula x aurata (B pendula x pubescens)	Betuxaur	
Betula pubescens	Betupube	
Betula utilis	Betuutil	
Bidens cernua	Bidecern	Includes B. cernua var.radiata
Bidens connata	Bideconn	
Bidens ferulifolia	Bideferu	
Bidens frondosa	Bidefron	
Bidens tripartita	Bidetrip	
Blackstonia perfoliata	Blacperf	
Blechnum spicant	Blecspic	
Blysmus compressus	Blyscomp	
Bolboschoenus maritimus	Bolbmari	
Borago officinalis	Boraoffi	
Botrychium lunaria	Botrluna	
Brachyglottis 'Sunshine' (B. compacta x laxifolia)	BracSuns	
Brachypodium pinnatum	Bracpinn	
Brachypodium sylvaticum	Bracsylv	
Brassica juncea	Brasjunc	
Brassica napus	Brasnapu	Includes B. napus ssp. oleifera
Brassica nigra	Brasnigr	
Brassica oleracea	Brasoler	Includes B. oleracea var.capitata
Brassica rapa	Brasrapa	Includes ssp. campestris, ssp. oleifera & ssp. rapa
Brassica tournefortii	Brastour	
Briza maxima	Brizmaxi	
Briza media	Brizmedi	
Bromopsis erecta	Bromerec	
Bromopsis inermis	Brominer	Includes ssp.inermis
Bromopsis ramosa	Bromramo	
Bromus commutatus	Bromcomm	
Bromus hordeaceus	Bromhord	Includes ssp. hordeaceus
Bromus lepidus	Bromlepi	
Bromus racemosus	Bromrace	
Bromus secalinus	Bromseca	
Bromus x pseudothominei (B. hordeaceus x lepidus)	Bromxpse	
Brunnera macrophylla	Brunmacr	
Bryonia dioica	Bryodioi	
Buddleja alternifolia	Buddalte	
Buddleja davidii	Budddavi	
Buddleja globosa	Buddglob	
Buddleja x weyeriana (B davidii x globosa)	Buddxwey	
Butomus umbellatus	Butoumbe	
Buxus sempervirens	Buxusemp	
Calamagrostis canescens	Calacane	
Calamagrostis epigejos	Calaepig	
Calendula officinalis	Caleoffi	
Callitriche hamulata	Callhamu	Includes C. hamulata sens.str.
Callitriche hermaphroditica	Callherm	
Callitriche obtusangula	Callobtu	
Callitriche platycarpa	Callplat	
Callitriche sp.	Callspec	Retained because many recorders have difficulties with segregates.
Callitriche stagnalis	Callstag	Includes C. stagnalis sens.str
Calluna vulgaris	Callvulg	
Caltha palustris	Caltpalu	

Calystegia pulchra	Calypulc	
Calystegia x howittiorum (C. pulchra x silvatica)	Calyxhow	
Calystegia x lucana (C. sepium x silvatica)	Calyxluc	
Calystegia sepium	Calysepi	Includes all C. Sepium subspecies
Calystegia silvatica	Calysilv	Includes C. silvatica var.quinquepartita
Camelina sativa	Camesati	
Campanula carpatica	Campcarp	
Campanula glomerata	Campglom	
Campanula latifolia	Camplati	
Campanula medium	Campmedi	
Campanula persicifolia	Camppers	
Campanula portenschlagiana	Campport	
Campanula poscharskyana	Campposc	
Campanula rapunculoides	Camprapu	
Campanula rotundifolia	Camprotu	
Campanula trachelium	Camptrac	
Cannabis sativa	Cannsati	
Capsella bursa-pastoris	Capsburs	
Cardamine amara	Cardamar	
Cardamine bulbifera	Cardbulb	
Cardamine flexuosa	Cardflex	
Cardamine hirsuta	Cardhirs	
Cardamine impatiens	Cardimpa	
Cardamine pratensis	Cardprat	
Carduus crispus	Cardcris	Includes C. crispus ssp.multiflorus
Carduus x dubius (C crispus x nutans)	Cardxdub	
Carduus nutans	Cardnuta	
Carex acuta	Careacut	
Carex acuta x nigra	Careacxn	
Carex acutiformis	Careacut	
Carex x subgracilis (C acutiformis x acuta)	Carexsub	
Carex arenaria	Carearen	
Carex binervis	Carebine	
Carex caryophyllea	Carecary	
Carex curta	Carecurt	
Carex diandra	Caredian	
Carex distans	Caredans	
Carex disticha	Caredist	
Carex divulsa	Caredivu	Includes C. divulsa ssp.divulsa
Carex echinata	Careechi	
Carex elata	Careelat	
Carex elongata	Careelon	
Carex flacca	Careflac	
Carex hirta	Carehirt	
Carex hostiana	Carehost	
Carex x fulva (C hostiana x viridula)	Carexful	
Carex laevigata	Carelaev	
Carex montana	Caremont	
Carex muricata	Caremuri	Includes ssp. lamprocarpa & ssp. muricata
Carex nigra	Carenigr	
Carex otrubae	Careotru	
Carex ovalis	Careoval	
Carex pallescens	Carepall	
Carex panicea	Carepani	
Carex paniculata	Carepani	
Carex pendula	Carepend	
Carex pilulifera	Carepilu	
Carex pseudocyperus	Carepseu	
Carex pulicaris	Carepuli	
Carex remota	Careremo	
Carex riparia	Careripa	
Carex rostrata	Carerost	
Carex spicata	Carespic	
Carex strigosa	Carestri	

Carex sylvatica	Caresylv	
Carex vesicaria	Carevesi	
Carex viridula	Careviri	Deleted
Carex viridula ssp.brachyrrhyncha	CarevSSb	
Carex viridula ssp. oedocarpa	CarevSSo	
Carex viridula ssp. viridula	CarevSSv	
Carlina vulgaris	Carlvulg	
Carpinus betulus	Carpbetu	
Carthamus tinctorius	Carttinc	
Castanea sativa	Castsati	
Catabrosa aquatica	Cataaqua	
Catalpa bignonoides	Catabign	
Catapodium rigidum	Catarigi	
Ceanothus divergens	Ceandive	
Cedrus atlantica	Cedratla	
Cedrus deodara	Cedrdeod	
Cedrus libani	Cedrliba	
Centaurea cyanus	Centcyan	
Centaurea deabalta	Centdeal	
Centaurea montana	Centmont	
Centaurea nigra	Centnigr	
Centaurea scabiosa	Centscab	
Centaurium erythraea	Centeryt	
Centranthus ruber	Centrube	
Cephalaria gigantea	Cephgiga	
Cerastium arvense	Ceraarve	
Cerastium arvense x tomentosum	Ceraxmau	
Cerastium diffusum	Ceradiff	
Cerastium fontanum	Cerafont	Includes subspecies
Cerastium glomeratum	Ceraglom	
Cerastium semidecandrum	Cerasemi	
Cerastium tomentosum	Ceratome	
Ceratocapnos claviculata	Ceraclav	
Ceratochloa carinata	Ceracari	
Ceratophyllum demersum	Cerademe	
Ceratophyllum submersum	Cerasubm	
Cercis siliquastrum	Cercsili	
Cerinthe major	Cerimajo	
Ceterach officinarum	Ceteoffi	
Chaenomeles speciosa	Chaespec	
Chaenorhinum minus	Chaeminu	
Chaerophyllum temulum	Chaetemu	
Chamaecyparis lawsoniana	Chamlaws	
Chamaecyparis nootkatensis	Chamnoot	Record deleted – arboretum single record
Chamaecyparis pisifera	Champisi	
Chamaemelum nobile	Chamnobi	
Chamerion angustifolium	Chamangu	
Chelidonium majus	Chelmaju	
Chenopodium album	Chenalbu	Includes Chenopodium album sens.str.
Chenopodium bonus-henricus	Chenbonu	
Chenopodium ficifolium	Chenfici	
Chenopodium giganteum	Chengiga	
Chenopodium glaucum	Chenglau	
Chenopodium hybridum	Chenhybr	
Chenopodium murale	Chenmura	
Chenopodium polyspermum	Chenpoly	
Chenopodium rubrum	Chenrubr	
Chenopodium urbicum	Chenurbi	
Chionodoxa forbesii	Chioforb	
Chionodoxa sardensis	Chiosard	
Chrysosplenium alternifolium	Chryalte	
Chrysosplenium oppositifolium	Chryoppo	
Cicerbita macrophylla	Cicemacr	
Cicerbita plumieri	Ciceplum	

Cichorium intybus	Cichinty	
Cicuta virosa	Cicuviro	
Circaea x intermedia (C alpina x lutetiana.)	Circxint	
Circaea lutetiana	Circlute	
Cirsium acaule	Cirsacau	
Cirsium arvense	Cirsarve	
Cirsium dissectum	Cirsdiss	
Cirsium eriophorum	Cirserio	
Cirsium heterophyllum	Cirshete	
Cirsium palustre	Cirspalu	
Cirsium vulgare	Cirsvulg	
Cladium mariscus	Cladmari	
Clarkia amoena	Claramoe	
Clarkia unguiculata	Clarungu	
Claytonia perfoliata	Clayperf	
Claytonia sibirica	Claysibi	
Claytonia virginica	Clayvirg	
Clematis montana	Clemmont	
Clematis tangutica	Clemtang	
Clematis vitalba	Clemvita	
Clinopodium acinos	Clinacin	
Clinopodium ascendens	Clinasce	
Clinopodium calamintha	Clincala	
Clinopodium vulgare	Clinvulg	
Cochlearia danica	Cochdani	
Cochlearia officinalis sens.str.	Cochoffi	
Coeloglossum viride	Coelviri	
Coincya monensis ssp. cheiranthos	Coinmone	
Colutea arborescens	Coluarbo	
Conium maculatum	Conimacu	
Conopodium majus	Conomaju	
Conringia orientalis	Conrorie	
Consolida ajacis	Consajac	
Convallaria majalis	Convmaja	
Convolvulus arvensis	Convarve	
Conyza bilbaoana	Conybilb	
Conyza bonariensis	Conybona	
Conyza canadensis	Conycana	
Conyza sumatrensis	Conysuma	
Cordyline australis	Cordaust	
Coriandrum sativum	Corisati	
Cornus alba	Cornalba	
Cornus mas	Cornmas	
Cornus sanguinea	Cornsang	
Cornus sericea	Cornseri	
Coronopus didymus	Corodidy	
Coronopus squamatus	Corosqua	
Cortaderia selloana	Cortsell	
Corydalis cheilanthifolia	Corychei	
Corydalis solida	Corysoli	
Corylus avellana	Coryavel	
Corylus maxima	Corymaxi	
Corynephorus canescens	Corycane	
Cosmos bipinnatus	Cosmbipi	
Cotinus coggygria	Coticogg	
Cotoneaster bullatus	Cotobull	
Cotoneaster buxifolius	Cotobuxi	
Cotoneaster x suecicus (C. conspicuus x dammeri)	Cotoxsue	
Cotoneaster dammeri	Cotodamm	
Cotoneaster dielsianus	Cotodiel	
Cotoneaster divaricatus	Cotodiva	
Cotoneaster franchetii	Cotofran	
Cotoneaster frigidus	Cotofrig	
Cotoneaster x watereri (C. frigidus x salicifolius)	Cotowate	

Cotoneaster hjelmqvistii	Cotohjel	
Cotoneaster horizontalis agg.	Cotohori	Includes C. horizontalis sens.str
Cotoneaster induratus	Cotoindu	
Cotoneaster integrifolius	Cotointe	
Cotoneaster lacteus	Cotolact	
Cotoneaster mairei	Cotomair	
Cotoneaster microphyllus agg.	Cotomicr	
Cotoneaster pannosus	Cotopann	
Cotoneaster rehderi	Cotorehd	
Cotoneaster salicifolius	Cotosali	
Cotoneaster simonsii	Cotosimo	
Cotoneaster sternianus	Cotoster	
Cotoneaster x suecicus 'Skogholm'	Cotox su	
Cotula coronopifolia	Cotucoro	
Cotula squalida	Cotusqua	
Crassula helmsii	Crashelm	
Crataegus crus-galli	Cratcrus	
Crataegus laciniata	Cratlaci	
Crataegus laevigata	Cratlaev	
Crataegus x media (C. laevigata x monogyna)	Cratxmed	
Crataegus monogyna	Cratmono	
Crataegus persimilis	Cratpers	
Crataegus x macrocarpa	Cratx ma	
Crepis biennis	Crepbien	
Crepis capillaris	Crepcapi	
Crepis nicaeensis	Crepnica	
Crepis paludosa	Creppalu	
Crepis vesicaria	Crepvesi	
Crocosmia paniculata	Crocpani	
Crocosmia pottsii x aurea (C. x crocosmiiflora)	Crocpott	
Crocus biflorus	Crocbifl	
Crocus chrysanthus	Crocchry	
Crocus flavus	Crocflav	
Crocus nudiflorus	Crocnudi	
Crocus sieberi	Crocsieb	
Crocus speciosus	Crocspec	
Crocus tommasinianus	Croctomm	
Crocus vernus	Crocvern	
Cruciata laevipes	Cruclaev	
Cryptomeria japonica	Crypjapo	
Cupressus goveniana	Cuprgove	
Cupressus macrocarpa x Xanthocyparis nootkatensis (x Cuprocyparis leylandi)	Cuprmacr	
Cuscuta epithymum	Cuscepit	
Cyclamen coum	Cyclcoum	
Cyclamen hederifolium	Cyclhede	
Cymbalaria muralis	Cymbmura	Includes C. muralis ssp.muralis
Cymbalaria pallida	Cymbpall	
Cynoglossum officinale	Cynooffi	
Cynosurus cristatus	Cynocris	
Cyperus eragrostis	Cypeerag	
Cyperus longus	Cypelong	
Cystopteris fragilis	Cystfrag	
Cytisus multiflorus	Cytimult	
Cytisus scoparius	Cytiscop	Includes C. scoparius ssp. scoparius
Cytisus striatus	Cytistri	
Daboecia cantabrica	Dabocant	
Dactylis glomerata	Dactglom	
Dactylorhiza fuchsii	Dactfuch	
Dactylorhiza x transiens (D. fuchsii x maculata)	Dactxtra	
Dactylorhiza x grandis (D. fuchsii x praetermissa)	Dactxgra	
Dactylorhiza x venusta (D. fuchsii x purpurella)	Dactxven	
Dactylorhiza incarnata	Dactinca	
Dactylorhiza maculata	Dactmacu	

Dactylorhiza praetermissa	Dactprae	
Dactylorhiza purpurella	Dactpurp	
Danthonia decumbens	Dantdecu	
Daphne laureola	Daphlaur	
Darmera peltata	Darmpelt	
Datura stramonium	Datustra	
Daucus carota ssp. carota	Dauccaro	
Daucus carota ssp. sativus	DauccSSs	
Deschampsia caespitosa	Desccaes	Includes ssp. caespitosa & ssp. parviflora
Deschampsia flexuosa	Descflex	
Descurainia sophia	Descsoph	
Deutzia scabra	Deutscab	
Dianthus barbatus	Dianbarb	
Dianthus deltoides	Diandelt	
Dianthus gratianopolitanus	Diangrat	
Dianthus plumarius	Dianplum	
Diascia barbarae	Diasbarb	
Dicentra formosa	Diceform	
Digitalis purpurea	Digipurp	
Digitaria ischaemum	Digiisch	
Digitaria sanguinalis	Digisang	
Diplotaxis muralis	Diplmura	
Diplotaxis tenuifolia	Dipltenu	
Dipsacus fullonum	Dipsfull	
Dipsacus laciniatus	Dipslaci	
Dipsacus pilosus	Dipspilo	
Dipsacus sativus	Dipssati	
Doronicum pardalianches	Doropard	
Doronicum x excelsum (D. columnae x pardalianches x plantagineum)	Doroxexc	
Dorycnium hirsutum	Doryhirs	
Draba muralis	Drabmura	
Drosera rotundifolia	Drosrotu	
Dryopteris affinis	Dryoaffi	Includes subspecies
Dryopteris carthusiana	Dryocart	
Dryopteris x deweveri (D. carthusiana x dilatata)	Dryoxdew	
Dryopteris dilatata	Dryodila	
Dryopteris filix-mas	Dryofili	
Duchesnea indica	Duchindi	
Echinochloa colona	Echicolo	
Echinochloa crus-galli	Echicrus	
Echinochloa esculenta	Echiescu	
Echinops bannaticus	Echibann	
Echinops exaltatus	Echiexal	
Echinops sphaerocephalus	Echispha	
Echium plantagineum	Echiplan	
Echium vulgare	Echivulg	
Eleocharis acicularis	Eleoacic	
Eleocharis palustris ssp. vulgaris	Eleopalu	
Eleocharis quinqueflora	Eleoquin	
Eleocharis uniglumis	Eleounig	
Eleogiton fluitans	Eleoflui	
Elodea canadensis	Elodcana	
Elodea nuttallii	Elodnutt	
Elymus caninus	Elymcani	
Elytrigia repens	Elytrepe	
Empetrum nigrum	Empenigr	Includes E. nigrum ssp. nigrum
Epilobium alsinifolium	Epilalsi	
Epilobium brunnescens	Epilbrun	
Epilobium ciliatum	Epilcili	
Epilobium x novae-civitatis (E. ciliatum x hirsutum)	Epilxnov	
Epilobium x interjectum (E. ciliatum x montanum	Epilxint	
Epilobium x vicinum (E. ciliatum x obscurum)	Epilxvic	
Epilobium x floridulum (E. ciliatum x parviflorum)	Epilxflo	

Epilobium hirsutum	Epilhirs	
Epilobium x erroneum (E hirsutum x montanum)	Epilxerr	
Epilobium lanceolatum	Epillanc	
Epilobium montanum	Epilxert	
Epilobium x aggregatum (E. montanum x obscurum)	Epilxagg	
Epilobium x montaniforme (E. montanum x palustre)	Epilxmon	
Epilobium obscurum	Epilobsc	
Epilobium x marshallianum (E. obscurum x anagallidifolium)	Epilxmar	
Epilobium x dacicum (E. obscurum x parviflorum)	Epilxdac	
Epilobium palustre	Epilpalu	
Epilobium parviflorum	Epilparv	
Epilobium roseum	Epilrose	
Epilobium tetragonum	Epiltetr	
Epipactis helleborine	Epiphell	
Epipactis phyllanthes	Epipphyl	
Epipactis purpurata	Epippurp	
Equisetum arvense	Equiarve	
Equisetum x litorale (E. arvense x fluviatile)	Equixlit	
Equisetum fluviatile	Equifluv	
Equisetum hyemale	Equihyem	
Equisetum palustre	Equipalu	
Equisetum sylvaticum	Equisylv	
Equisetum telmateia	Equitelm	
Eranthis hyemalis	Eranhyem	
Erica cinerea	Ericcine	
Erica tetralix	Erictetr	
Erigeron acer	Erigacer	
Erigeron glaucus	Erigglau	
Erigeron karvinskianus	Erigkarv	
Erigeron philadelphicus	Erigphil	
Erigeron speciosus	Erigspec	
Eriophorum angustifolium	Erioangu	
Eriophorum vaginatum	Eriovagi	
Erodium cicutarium	Erodcicu	Includes subspecies
Erodium maritimum	Erodmari	
Erodium moschatum	Erodmosc	
Erophila glabrescens	Eropglab	
Erophila majuscula	Eropmaju	
Erophila verna sens. lat.	Eropvern	Includes E. verna ssp. verna
Eruca vesicaria	Erucvesi	
Eryngium giganteum	Eryngiga	
Eryngium planum	Erynplan	
Eryngium variifolium	Erynvari	
Erysimum cheiranthoides	Erysches	
Erysimum cheiri	Eryschri	
Erysimum x marshallii (E. decumbens x perofskianum)	Erysxmar	
Erythronium denscanis	Erytdens	
Escallonia macrantha	Escamacr	
Escallonia x langleyensis	Escax la	
Eschscholzia californica	Eschcali	
Eucalyptus gunnii	Eucagunn	
Eucalyptus perriniana	Eucaperr	
Euonymus europaeus	Euoneuro	
Euonymus japonicus	Euonjapo	
Euonymus latifolius	Euonlati	
Eupatorium cannabinum	Eupacann	
Euphorbia amygdaloides	Euphamyg	Includes ssp. amygdaloides & ssp. robbiae
Euphorbia characias	Euphchar	
Euphorbia cyparissias	Euphcypa	
Euphorbia dulcis	Euphdulc	
Euphorbia esula	Euphesul	
Euphorbia exigua	Euphexig	

Euphorbia helioscopia	Euphheli	
Euphorbia lathyris	Euphlath	
Euphorbia maculata	Euphmacu	
Euphorbia myrsinites	Euphmyrs	
Euphorbia oblongata	Euphoblo	
Euphorbia peplus	Euphpepl	
Euphorbia serrulata	Euphserr	
Euphorbia x pseudovirgata agg.	Euphxpse	
Euphorbia waldsteinii	Euphwald	
Euphrasia species	Euphspec	Includes all Ephrasia spp. & ssp.
Euphrasia anglica		In Euphrasia species
Euphrasia anglica x nemorosa (E. x glanduligera)		"
Euphrasia arctica ssp. borealis		"
Euphrasia confusa		"
Euphrasia nemorosa		"
Euphrasia officinalis agg.		"
Euphrasia rostkoviana		"
Fagopyrum esculentum	Fagoescu	
Fagopyrum tataricum	Fagotata	
Fagus sylvatica	Fagusylv	
Fallopia baldschuanica	Fallbald	
Fallopia convolvulus	Fallconv	
Fallopia japonica	Falljapo	
Fallopia sachalinensis	Fallsach	
Ferula communis	Ferucomm	
Festuca altissima	Festalti	
Festuca arundinacea	Festarun	
Festuca arundinacea x Lolium multiflorum	Festaxlo	
Festuca brevipila	Festbrev	
Festuca filiformis	Festfili	
Festuca gigantea	Festgiga	
Festuca ovina agg.	Festovin	
Festuca pratensis	Festprat	
Festuca pratensis x Lolium multiflorum (x Festulolium braunii)	Festxmul	
Festuca pratensis x Lolium perenne (x Festulolium loliaceum)	Festxper	
Festuca rubra agg.	Festrubr	
Festuca rubra ssp. commutata	FestrSSc	
Festuca rubra ssp. juncea	FestrSSj	
Festuca rubra ssp. megastachys	FestrSSm	
Festuca rubra ssp. rubra		In Festuca rubra agg.
Ficus carica	Ficucari	
Filago arvensis	Filaarve	
Filago minima	Filamini	
Filago vulgaris	Filavulg	
Filipendula ulmaria	Filiulma	
Filipendula vulgaris	Filivulg	
Foeniculum vulgare	Foenvulg	
Forsythia suspensa	Forssusp	
Forsythia x intermedia (F suspensa x viridissima)	Forsxint	
Fragaria ananassa	Fraganan	
Fragaria vesca	Fragvesc	
Frangula alnus	Franalnu	
Fraxinus angustifolia 'Raywood'		Record deleted – arboretum single record
Fraxinus excelsior	Fraxexce	
Fraxinus latifolia	Fraxlati	
Fraxinus ornus	Fraxornu	
Fritillaria meleagris	Fritmele	
Fuchsia magellanica	Fuchmage	
Fumaria capreolata	Fumacapr	Includes F. capreolata ssp. babingtonii
Fumaria muralis	Fumamura	Includes F. muralis ssp. boraei
Fumaria officinalis	Fumaoffi	Includes ssp. officinalis & ssp. wirtgenii
Fumaria purpurea	Fumapurp	

Gagea lutea	Gagelute	
Galanthus elwesii	Galaelwe	
Galanthus ikariae	Galaikar	
Galanthus latifolius x nivalis	Galalati	
Galanthus nivalis	Galaniva	
Galanthus nivalis x plicatus	Galanxpl	
Galanthus plicatus	Galaplic	
Galanthus woronowii	Galaworo	
Galeopsis angustifolia	Galeangu	
Galega officinalis	Galeoffi	
Galeopsis segetum	Galesege	
Galeopsis speciosa	Galespec	
Galeopsis tetrahit agg.	Galetagg	Includes G. tetrahit sens. str. and G.bifida
Galinsoga parviflora	Galiparv	
Galinsoga quadriradiata	Galiquad	
Galium aparine	Galiapar	
Galium mollugo	Galimoll	Includes G. mollugo ssp. mollugo
Galium mollugo ssp. erectum	GalimSSe	
Galium mollugo x verum (G. x pomeranicum)	Galixpom	
Galium odoratum	Galiodor	
Galium palustre	Galipalu	Includes ssp. elongatum & ssp. palustre
Galium parisiense	Galipari	
Galium saxatile	Galisaxa	
Galium sterneri	Galister	
Galium uliginosum	Galiulig	
Galium verum	Galiveru	
Gaultheria mucronata	Gaulmucr	
Gaultheria shallon	Gaulshal	
Genista tinctoria	Genitinc	
Gentianella amarella	Gentamar	
Gentianella campestris	Gentcamp	
Geranium columbinum	Geracolu	
Geranium dalmaticum	Geradalm	
Geranium dissectum	Geradiss	
Geranium endressii	Geraendr	
Geranium x oxonianum (G endressii x versicolor)	Geraxoxo	
Geranium ibericum x platypetalum (G. x magnificum)	Geraiber	
Geranium lucidum	Geraluci	
Geranium macrorrhizum	Geramacr	
Geranium molle	Geramoll	
Geranium phaeum	Geraphae	
Geranium pratense	Geraprat	
Geranium psilostemon	Gerapsil	
Geranium purpureum	Gerapurp	
Geranium pusillum	Gerapusi	
Geranium pyrenaicum	Gerapyre	
Geranium robertianum	Gerarobe	
Geranium rotundifolium	Gerarotu	
Geranium rubescens	Gerarube	
Geranium sanguineum	Gerasang	
Geranium sylvaticum	Gerasylv	
Geranium versicolor	Geravers	
Geum rivale	Geumriva	
Geum x intermedium (G rivale x urbanum.)	Geumxint	
Geum urbanum	Geumurba	
Ginkgo biloba	Ginkbilo	
Glaux maritima	Glaumari	
Glebionis coronaria	Glebcoro	
Glebionis segetum	Glebsege	
Glechoma hederacea	Glechede	
Glyceria declinata	Glycdecl	
Glyceria fluitans	Glycflui	
Glyceria x pedicellata G fluitans x notata)	Glycxped	

Glyceria maxima	Glycmaxi	
Glyceria notata	Glycnota	
Gnaphalium luteoalbum	Gnaplute	
Gnaphalium sylvaticum	Gnapsylv	
Gnaphalium uliginosum	Gnapulig	
Guizotia abyssinica	Guizabys	
Gunnera manicata	Gunnmani	
Gunnera tinctoria	Gunntinc	
Gymnadenia conopsea	Gymncono	
Gymnocarpium dryopteris	Gymndryo	
Gymnocarpium robertianum	Gymnrobe	
H Sect Exotericum	HierSExo	Deleted
H sect Foliosa	HierSFol	Deleted
H Sect Hieracium	HierSHie	Deleted
H sect Sabauda	HierSSab	Deleted
H Sect Stelligera	HierSSte	Deleted
H Sect Vulgata	HierSVul	Deleted
H. Sect Heiracioides	HierSHei	Deleted
Hebe brachysiphon	Hebebrac	
Hebe dieffenbachii	Hebedief	
Hebe elliptica x speciosa (H. x franciscana)	Hebeelli	
Hedera canariensis	Hedecana	
Hedera colchica	Hedecolc	
Hedera helix		Deleted
Hedera helix 'Hibernica'	HedeHibe	
Hedera helix ssp. helix	Hedeheli	
Helianthemum nummularium	Helinumm	
Helianthus annuus	Heliannu	
Helianthus x multiflorus (H. annuus x decapetalus)	Helixmul	
Helianthus petiolaris	Helipeti	
Helianthus tuberosus	Helitube	
Helichrysum italicum	Heliital	
Helictotrichon pratense	Heliprat	
Helictotrichon pubescens	Helipube	
Heliotropium arborescens	Heliarbo	
Helleborus argutifolius	Hellargu	
Helleborus foetidus	Hellfoet	
Helleborus orientalis	Hellorie	
Helleborus viridis	Hellviri	
Hemerocallis fulva	Hemefulv	
Hemerocallis lilioasphodelus	Hemelili	
Heracleum mantegazzianum	Heramant	
Heracleum sphondylium	Heraspho	Includes H. sphondylium ssp.flavescens
Herniaria glabra	Hernglab	
Hesperis matronalis	Hespmatr	
Heuchera sanguinea	Heucsang	
Hieraceum argillaceum	Hierargi	
Hieracium acuminatum	Hieracum	
Hieracium britannicum	Hierbrit	
Hieracium cinderella	Hiercind	
Hieracium consociatum	Hiercons	
Hieracium diaphanum	Hierdiap	
Hieracium exotericum	Hierexot	
Hieracium pollichiae	Hierpoll	
Hieracium sabaudum	Hiersaba	
Hieracium salticola	Hiersalt	
Hieracium scotostictum	Hierscot	
Hieracium sp.	Hiersp.	Deleted
Hieracium subaequailtum	Hiersuba	
Hieracium subcrocatum	Hiersubc	
Hieracium sublepistoides	Hiersubl	
Hieracium subprasinifolium	Hiersubp	
Hieracium umbellatum	Hierumbe	

Hieracium vagum	Hiervagu	
Hieracium vulgatum	Hiervulg	
Hippocrepis comosa	Hippcomo	
Hippophae rhamnoides	Hipprham	
Hippuris vulgaris	Hippvulg	
Hirschfeldia incana	Hirsinca	
Holcus lanatus	Holclana	
Holcus mollis	Holcmoll	
Holodiscus discolor	Holodisc	
Hordelymus europaeus	Hordeuro	
Hordeum distichon sens.lat.	Horddist	
Hordeum jubatum	Hordjuba	
Hordeum murinum	Hordmuri	
Hordeum secalinum	Hordseca	
Hordeum vulgare	Hordvulg	
Hornungia petraea	Hornpetr	
Hottonia palustris	Hottpalu	
Humulus lupulus	Humulupu	
Hyacinthoides hispanica	Hyachisp	
Hyacinthoides x massartiana (H hispanica x non-scripta)	Hyacxmas	
Hyacinthoides non-scripta	Hyacnon-	
Hyacinthus orientalis	Hyacorie	
Hydrocharis morsus-ranae	Hydrmors	
Hydrocotyle ranunculoides	Hydrranu	
Hydrocotyle sibthorpioides	Hydrsibt	
Hydrocotyle vulgaris	Hydrvulg	
Hyoscyamus niger	Hyosnige	
Hypericum androsaemum	Hypeandr	
Hypericum androsaemum x hircinum (H. x inodorum)	Hypexino	
Hypericum calycinum	Hypecaly	
Hypericum elodes	Hypeelod	
Hypericum 'Hidcote'	Hype'Hid	
Hypericum hircinum	Hypehirc	
Hypericum hirsutum	Hypehirs	
Hypericum humifusum	Hypehumi	
Hypericum maculatum	Hypemacu	Includes H. maculatum obtusiusculum
Hypericum maculatum x perforatum (H. x desetangsii)	Hypexdes	
Hypericum montanum	Hypemont	
Hypericum olympicum	Hypeolym	
Hypericum perforatum	Hypeperf	
Hypericum pulchrum	Hypepulc	
Hypericum tetrapterum	Hypetetr	
Hypericum x desetangsii nothossp. carinthiacum	Hypex de	
Hypochaeris glabra	Hypoglab	
Hypochaeris radicata	Hyporadi	
Iberis sempervirens	Ibersemp	
Iberis umbellata	Iberumbe	
Ilex aquifolium	Ilexaqui	
Ilex aquifolium x perado (I. x altaclerensis)	Ilexxalt	
Impatiens capensis	Impacape	
Impatiens glandulifera	Impaglan	
Impatiens parviflora	Impaparv	
Impatiens walleriana	Impawall	
Inula conyzae	Inulcony	
Inula helenium	Inulhele	
Iris ensata	Irisensa	
Iris foetidissima	Irisfoet	
Iris germanica	Irisgerm	
Iris pseudacorus	Irispseu	
Iris sibirica	Irissibi	
Iris sp. cultivar	Irissp.	
Iris versicolor	Irisvers	

Isatis tinctoria	Isattinc	
Isolepis setacea	Isolseta	
Isotoma axillaris	Isotaxil	
Iva xanthiifolia	Ivaxant	
Jasione montana	Jasimont	
Jasminum nudiflorum	Jasmnudi	
Jasminum officinale	Jasmoffi	
Juglans regia	Juglregi	
Juncus acutiflorus	Juncacut	
Juncus ambiguus	Juncambi	
Juncus articulatus	Juncarti	
Juncus articulatus x acutiflorus = J. x surrejanus	Juncxsur	
Juncus bufonius agg.	Juncbagg	Includes J. bufonius sens. str.
Juncus bulbosus	Juncbulb	
Juncus compressus	Junccomp	
Juncus conglomeratus	Junccong	
Juncus effusus	Junceffu	Includes J. effusus var. subglomeratus
Juncus effusus x inflexus (J. x diffusus)	Juncxdif	
Juncus gerardii	Juncgera	
Juncus inflexus	Juncinfl	
Juncus squarrosus	Juncsqua	
Juncus subnodulosus	Juncsubn	
Juncus tenuis	Junctenu	
Juniperus communis	Junicomm	
Juniperus communis ssp.nana	JunicSSn	
Kerria japonica	Kerrjapo	
Kickxia elatine	Kickelat	
Knautia arvensis	Knauarve	
Kniphofia praecox	Knipprae	
Kniphofia uvaria	Knipuvar	
Koeleria macrantha	Koelmacr	
Koelreuteria paniculata	Koelpani	
Laburnum alpinum x anagyroides (L. x watereri)	Labuxwat	
Laburnum anagyroides	Labuanag	
Lactuca sativa	Lactsati	
Lactuca serriola	Lactserr	
Lactuca virosa	Lactviro	
Lagarosiphon major	Lagamajo	
Lagurus ovatus	Laguovat	
Lamiastrum galeobdolon	Lamigale	Deleted
Lamiastrum galeobdolon ssp. argentatum	LamigSSa	
Lamiastrum galeobdolon ssp. montanum	LamigSSm	
Lamium album	Lamialbu	
Lamium amplexicaule	Lamiampl	
Lamium hybridum	Lamihybr	
Lamium maculatum	Lamimacu	
Lamium purpureum	Lamipurp	
Lapsana communis	Lapscomm	
Larix decidua	Larideci	
Larix decidua x kaempferi (L. x marschlinsii)	Larixmar	
Larix kaempferi	Larikaem	
Lathraea squamaria	Lathsqua	
Lathyrus aphaca	Lathapha	
Lathyrus grandiflorus	Lathgran	
Lathyrus hirsutus	Lathhirs	
Lathyrus latifolius	Lathlati	
Lathyrus linifolius	Lathlini	
Lathyrus nissolia	Lathniss	
Lathyrus odoratus	Lathodor	
Lathyrus pratensis	Lathprat	
Lathyrus sylvestris	Lathsylv	
Laurus nobilis	Laurnobi	

Lavandula angustifolia x latifolia (L. x intermedia)	Lavaangu	
Lavatera arborea	Lavaarbo	
Lavatera x clementii	Lavaolbi	
Lavatera thuringiaca	Lavathur	
Lavatera trimestris	Lavatrim	
Lemna gibba	Lemngibb	
Lemna minor	Lemnmino	
Lemna minuta	Lemnminu	
Lemna trisulca	Lemntris	
Leontodon autumnalis	Leonautu	
Leonurus cardiaca	Leoncard	
Leontodon hispidus	Leonhisp	
Leontodon saxatilis	Leonsaxa	
Lepidium campestre	Lepicamp	
Lepidium draba	Lepidrab	Includes L. draba ssp. draba
Lepidium heterophyllum	Lepihete	
Lepidium latifolium	Lepilati	
Lepidium ruderale	Lepirude	
Lepidium sativum	Lepisati	
Lepidium virginicum	Lepivirg	
Leucojum aestivum	Leucaest	Includes L. aestivum ssp.pulchellum
Leucanthemum x superbum (L. lacustre x maximum)	Leuclacu	
Leucanthemum vulgare	Leucvulg	
Levisticum officinale	Levioffi	
Leycesteria formosa	Leycform	
Ligustrum ovalifolium	Liguoval	
Ligustrum vulgare	Liguvulg	
Lilium martagon	Lilimart	
Lilium pyrenaicum	Lilipyre	
Limnanthes douglasii	Limndoug	
Limosella aquatica	Limoaqua	
Linaria maroccana	Linamaro	
Linaria purpurea	Linapurp	
Linaria purpurea x repens (L. x dominii)	Linaxdom	
Linaria repens	Linarepe	
Linaria repens x vulgaris (L. x sepium)	Linaxsep	
Linaria vulgaris	Linavulg	
Linum bienne	Linubien	
Linum catharticum	Linucath	
Linum flavum	Linuflav	
Linum usitatissimum	Linuusit	
Liriodendron tulipifera	Lirituli	
Listera ovata	Listovat	
Lithospermum arvense	Litharve	
Lithospermum officinale	Lithoffi	
Lithospermum purpureocaeruleum	Lithpurp	
Littorella uniflora	Littunif	
Lobelia erinus	Lobeerin	
Lobularia maritima	Lobumari	
Lolium multiflorum	Lolimult	
Lolium multiflorum x perenne (L. x boucheanum)	Lolixbou	
Lolium perenne	Lolipere	
Lonicera caprifolium x etrusca (L. x italica)	Lonixita	
Lonicera henryi	Lonihenr	
Lonicera involucrata	Loniinvo	
Lonicera japonica	Lonijapo	
Lonicera nitida	Loniniti	
Lonicera periclymenum	Loniperi	
Lonicera pileata	Lonipile	
Lonicera tatarica	Lonitata	
Lonicera xylosteum	Lonixylo	

Lotus corniculatus	Lotucorn	
Lotus corniculatus var. sativus	LotuscSSs	
Lotus pedunculatus	Lotupedu	
Lotus tenuis	Lotutenu	Should be L. glaber
Lunaria annua	Lunaannu	
Lunaria rediviva	Lunaredi	
Lupinus arboreus	Lupiarbo	
Lupinus arboreus x polyphyllus (L. x regalis)	Lupixreg	
Lupinus polyphyllus	Lupipoly	
Luronium natans	Luronata	
Luzula campestris	Luzucamp	
Luzula multiflora	Luzumult	Includes ssp. congesta & ssp. multiflora
Luzula pilosa	Luzupilo	
Luzula sylvatica	Luzusylv	
Lychnis chalcedonica	Lychchal	
Lychnis coronaria	Lychcoro	
Lychnis flos-cuculi	Lychflos	
Lychnis viscaria	Lychvisc	
Lycium barbarum	Lycibarb	
Lycium chinense	Lycichin	
Lycium sp.	Lycisp.	Deleted
Lycopodium clavatum	Lycoclav	
Lycopersicon esculentum	Lycoescu	
Lycopus europaeus	Lycoeuro	
Lysichiton americanus	Lysiamer	
Lysimachia ciliata	Lysicili	
Lysimachia nemorum	Lysinemo	
Lysimachia nummularia	Lysinumm	
Lysimachia punctata	Lysipunc	
Lysimachia vulgaris	Lysivulg	
Lythrum portula	Lythport	
Lythrum salicaria	Lythsali	
Macleaya x kewensis (M. cordata x microcarpa)	Maclcord	
Mahonia aquifolium	Mahoaqui	
Malcolmia maritima	Malcmari	
Malus atrosanguinea x niedzwetzkyana (M. x purpurea)	Maluatro	
Malus baccata	Malubacc	
Malus floribunda	Maluflor	
Malus sylvestris sens. lat.	Malupumi	Includes M. sylvestris sens. str., M. pumila, M. domestica
Malus x robusta	Maluxrob	
Malva alcea	Malvalce	
Malva moschata	Malvmosc	
Malva neglecta	Malvnegl	
Malva parviflora	Malvparv	
Malva sylvestris	Malvsylv	
Marrubium vulgare	Marrvulg	
Matricaria discoidea	Matrdisc	
Matricaria recutita	Matrrecu	
Matteuccia struthiopteris	Mattstru	
Meconopsis cambrica	Mecocamb	
Medicago arabica	Mediarab	
Medicago lupulina	Medilupu	
Medicago polymorpha	Medipoly	
Medicago sativa	Medisati	Includes ssp. sativa & ssp. varia
Melampyrum pratense	Melaprat	Includes M. pratense ssp. pratense
Melilotus albus	Melialbu	
Melilotus altissimus	Melialti	
Melilotus indicus	Meliindi	
Melica nutans	Melinuta	
Melilotus officinalis	Melioffi	
Melissa officinalis	Mssaoffi	
Melica uniflora	Meliunif	
Mentha aquatica	Mentaqua	
Mentha arvensis	Mentarve	

Mentha pulegium	Mentpule	
Mentha requienii	Mentrequ	
Mentha spicata	Mentspic	
Mentha suaveolens	Mentsuav	
Mentha arvensis x spicata (M. x gracilis)	Mentxgra	
Mentha aquatica x spicata (M. x piperita)	Mentxpip	Includes var. citrata
Mentha x smithiana (M. aquatica x arvensis x spicata)	Mentxsmi	
Mentha aquatica x arvensis (M. x verticillata)	Mentxver	
Mentha spicata x suaveolens (M. x villosa)	Mentxvsa	Includes var. alopecuroides & var. villosa
Mentha longifolia x spicata (M. x villosonervata)	Mentxvta	
Menyanthes trifoliata	Menytrif	
Mercurialis annua	Mercannu	
Mercurialis perennis	Mercpere	
Mespilus germanica	Mespgerm	
Metasequoia glyptostroboides	Metaglyp	
Milium effusum	Milieffu	
Mimulus guttatus	Mimugutt	
Mimulus luteus	Mimulute	
Mimulus moschatus	Mimumosc	
Mimulus guttatus x luteus (M. x robertsii)	Mimuxrob	
Mimulus sp.	Mimusp.	Deleted
Minuartia verna	Minuvern	
Miscanthus sinensis	Miscsine	
Misopates orontium	Misooron	
Moehringia trinervia	Moehtrin	
Molinia caerulea	Molicaer	Includes ssp. arundinacea & ssp. caerulea
Monotropa hypopitys	Monohypo	Includes ssp. hypophegea
Montia fontana	Montfont	Includes ssp. fontana & ssp. variabilis
Morus nigra	Morunigr	
Melissa officinalis	Mssaoffi	
Muscari armeniacum	Muscarme	
Muscari botryoides	Muscbotr	
Muscari neglectum	Muscnegl	
Mycelis muralis	Mycemura	
Myosoton aquaticum	Myosaqua	
Myosotis arvensis	Myosarve	
Myosotis discolor	Myosdisc	
Myosotis laxa	Myoslaxa	
Myosurus minimus	Myosmini	
Myosotis ramosissima	Myosramo	
Myosotis scorpioides	Myosscor	
Myosotis secunda	Myossecu	
Myosotis sylvatica	Myossylv	
Myriophyllum alterniflorum	Myrialte	
Myriophyllum aquaticum	Myriaqua	
Myrica gale	Myrigale	
Myriophyllum spicatum	Myrispic	
Myriophyllum verticillatum	Myrivert	
Myrrhis odorata	Myrrodor	
Narcissus poeticus	Narcpoet	
Narcissus pseudonarcissus	Narcpseu	Includes ssp. major
Narcissus pseudonarcissus ssp. pseudonarcissus	NarcpSSp	
Narcissus poeticus x tazetta (N. x medioluteus)	Narctaze	
Narcissus poeticus x pseudonarcissus (N. x incomparabilis)	Narcxinc	
Nardus stricta	Nardstri	
Narthecium ossifragum	Nartossi	
Nectaroscordum siculum	Nectsicu	
Nemesia strumosa	Memestru	
Nepeta nepetella x racemosa (N. x faassenii)	Nepenepe	
Nicandra physalodes	Nicaphys	
Nicotiana alata	Nicoalat	
Nicotiana forgetiana	Nicoforg	

Nicotiana tabacum	Nicotaba	
Nicotiana alata x forgetiana (N. x sanderae)	Nicoxsan	
Nigella damascena	Nigedama	
Nonea lutea	Nonelute	
Nothofagus alpina	Nothalpi	
Nothofagus antartica	Nothanta	
Nothofagus nervosa	Nothnerv	
Nothofagus obliqua	Nothobli	
Nothofagus obliqua x menziesii	Nothoxme	
Nuphar lutea	Nuphlute	
Nuphar lutea x pumila (N. x spenneriana)	Nuphxspe	
Nymphaea alba	Nympalba	
Nymphaea marliacea	Nympmarl	
Nymphoides peltata	Nymppelt	
Ocimum micranthum	Ocimmicr	
Odontites vernus	Odonvern	Includes Odontites vernus ssp. serotinus
Oenanthe aquatica	Oenaaqua	
Oenanthe crocata	Oenacroc	
Oenanthe fistulosa	Oenafist	
Oenanthe lachenalii	Oenalach	
Oenanthe pimpinelloides	Oenapimp	
Oenothera biennis	Oenobien	
Oenothera biennis x cambrica	Oenobxca	
Oenothera cambrica	Oenocamb	
Oenothera fallax	Oenofall	
Oenothera glazioviana	Oenoglaz	
Oenothera stricta	Oenostri	
Oenothera biennis x glazioviana	Oenoxfal	
Oenothera sp.	Oenosp.	Deleted
Olearia avicenniifolia x moschata (O. x haastii)	Oleaavic	
Onobrychis viciifolia	Onobvici	
Onoclea sensibilis	Onocsens	
Ononis repens	Ononrepe	Includes Ononis repens ssp. maritima
Ononis spinosa	Ononspin	
Onopordum acanthium	Onopacan	
Ophioglossum vulgatum	Ophivulg	
Ophrys apifera	Ophrapif	
Orchis mascula	Orchmasc	
Orchis morio	Orchmori	
Oreopteris limbosperma	Oreolimb	
Origanum vulgare	Origvulg	
Ornithogalum angustifolium	Orniangu	
Ornithopus perpusillus	Orniperp	
Ornithogalum pyrenaicum	Ornipyre	
Orobanche elatior	Orobelat	
Orobanche minor	Orobmino	
Orobanche rapum-genistae	Orobrapu	
Osmunda regalis	Osmurega	
Osteospermum ecklonis	Osteeckl	
Oxalis acetosella	Oxalacet	
Oxalis articulata	Oxalarti	
Oxalis corniculata	Oxalcorn	
Oxalis debilis	Oxaldebi	
Oxalis exilis	Oxalexil	
Oxalis incarnata	Oxalinca	
Oxalis rosea	Oxalrose	
Oxalis stricta	Oxalstri	
Oxyria digyna	Oxyrdigy	
Paeonia officinalis	Paeooffi	
Panicum capillare	Panicapi	
Panicum miliaceum	Panimili	
Papaver argemone	Papaarge	
Papaver atlanticum	Papaatla	
Papaver dubium ssp. lecoqii	PapadSSl	

Papaver dubium	Papadubi	Includes Papaver dubium ssp. dubium
Papaver orientale	Papaorie	
Papaver rhoeas	Paparhoe	
Papaver somniferum	Papasomn	
Parentucellia viscosa	Parevisc	
Parietaria judaica	Parijuda	
Paris quadrifolia	Pariquad	
Parnassia palustris	Parnpalu	
Parthenocissus quinquefolia	Partquin	
Parthenocissus tricuspidata	Parttric	
Pastinaca sativa	Pastsati	Includes var. hortensis & var. sylvestris
Paulownia tomentosa	Paultome	Deleted
Pedicularis palustris	Pedipalu	
Pedicularis sylvatica	Pedisylv	
Pentaglottis sempervirens	Pentsemp	
Peperomia pellucida	Pepepell	
Persicaria alpina	Persalpi	
Persicaria amphibia	Persamph	
Persicaria amplexicaulis	Persampl	
Persicaria bistorta	Persbist	
Persicaria campanulata	Perscamp	
Persicaria capitata	Perscapi	
Persicaria hydropiper	Pershydr	
Persicaria lapathifolia	Perslapa	
Persicaria maculosa	Persmacu	
Persicaria minor	Persmino	
Persicaria mitis	Persmiti	
Persicaria wallichii	Perswall	
Persicaria hydropiper x laxiflora (P. x hybrida)	Persxhyb	
Petasites albus	Petaalbu	
Petasites fragrans	Petafrag	
Petasites hybridus	Petahybr	
Petasites japonicus	Petajapo	
Petroselinum crispum	Petrcris	
Petunia axillaris x integrifolia (P. x hybrida)	Petuaxil	
Peucedanum ostruthium	Peucostr	
Phacelia tanacetifolia	Phactana	
Phalaris arundinacea	Phalarun	
Phalaris canariensis	Phalcana	
Phalaris paradoxa	Phalpara	
Phaseolus coccineus	Phascocc	
Phegopteris connectilis	Phegconn	
Philadelphus coronarius	Philcoro	
Philadelphus x virginalis (P. coronarius x microphyllus x pubescens)	Philxvir	
Phleum bertolonii	Phlebert	
Phleum pratense sens.lat.	Phleprat	Includes Phleum pratense sens.str.
Phlox paniculata	Phlopani	
Photinia davidiana	Photdavi	
Phragmites australis	Phraaust	
Phuopsis stylosa	Phuostyl	
Phyllitis scolopendrium	Phylscol	
X Asplenophyllitis conflu	Phylxasp	
Physalis alkekengi	Physalke	
Physocarpus opulifolius	Physopul	
Phytolacca acinosa	Phytacin	
Picea abies	Piceabie	
Picea breweriana		Deleted
Picea omorika		Deleted
Picea pungens		Deleted
Picea sitchensis	Picesitc	
Picris echioides	Picrechi	
Picris hieracioides	Picrhier	
Pilosella aurantiaca	Piloaura	Includes ssp. aurantiaca & ssp. carpathicola

Pilosella x floribunda	Pilocaes	
Pilosella officinarum	Pilooffi	
Pilosella praealta	Piloprae	
Pilosella aurantiaca x officinarum (P. x stoloniflora)	Piloxsto	
Pimpinella major	Pimpmajo	
Pimpinella saxifraga	Pimpsaxi	
Pinus contorta	Pinucont	
Pinus nigra ssp. laricio	PinunSSl	
Pinus nigra ssp. nigra	PinunSSn	
Pinus pinaster	Pinupina	
Pinus ponderosa	Pinupond	
Pinus radiata	Pinuradi	
Pinus strobus	Pinustro	
Pinus sylvestris	Pinusylv	
Pinus wallichiana	Pinuwall	
Pisum sativum	Pisusati	
Plagiobothrys scouleri	Plagscou	
Plantago coronopus	Plancoro	
Plantago lanceolata	Planlanc	
Plantago major	Planmajo	Includes ssp. intermedia & ssp. major
Plantago maritima	Planmari	
Plantago media	Planmedi	
Platanthera bifolia	Platbifo	
Platanthera chlorantha	Platchlo	
Platanus occidentalis	Planocci	
Platanus orientalis	Platorie	
Platanus x hispanica (P. occidentalis x orientalis)	Platxhis	
Poa angustifolia	Poaangu	
Poa annua	Poaannu	
Poa chaixii	Poachai	
Poa compressa	Poacomp	
Poa humilis	Poahumi	
Poa nemoralis	Poanemo	
Poa palustris	Poapalu	
Poa pratensis sens.lat.	Poaprat	Includes Poa pratensis sens.str.
Poa trivialis	Poatriv	
Polypodium vulgare agg.	Poldvule	Includes Polypodium vulgare sens. str.
Polemonium caeruleum	Polecaer	
Polemonium pauciflorum	Polepauc	
Polygala vulgaris	Polgvuls	
Polystichum aculeatum	Polyacul	
Polygonum arenastrum	Polyaren	
Polygonum aviculare agg.	Polyavic	Includes Polygonum aviculare sens.str.
Polygonum cognatum	Polycogn	
Polypodium interjectum	Polyinte	
Polypogon monspeliensis	Polymons	
Polygonatum multiflorum	Polymult	
Polygonum rurivagum	Polyruri	
Polygala serpyllifolia	Polyserp	
Polystichum setiferum	Polyseti	
Polycarpon tetraphyllum	Polytetr	
Polygonatum verticillatum	Polyvert	
Polypogon viridis	Polyviri	
Polygonatum multiflorum x odoratum (P. x hybridum)	Polyxhyb	
Polypodium interjectum x vulgare (P. x mantoniae)	Polyxman	
Populus alba	Popualba	
Populus alba x tremula (P. x canescens)	Popuaxtr	
Populus balsamifera	Popubals	
Populus candicans	Popucand	
Populus nigra	Popunigr	
Populus nigra 'Italica'	PopunIta	
Populus nigra ssp. betulifolia	PopunSSb	
Populus x canadensis ‘Serotina’	PopuSero	
Populus tremula	Poputrem	

Populus trichocarpa	Poputric	
Populus 'Balsam Spire' (P. balsamifera x trichocarpa)	Poputxba	
Populus x berolinensis	Popuxber	
Populus x canadensis (P. deltoides x nigra)	Popuxcan	
Populus x canadensis 'Serotina' x candicans	Popuxcxb	
Populus x jackii	Popuxjac	
Potamogeton alpinus	Potaalpi	
Potamogeton berchtoldii	Potaberc	
Potamogeton compressus	Potacomp	
Potamogeton crispus	Potacris	
Potamogeton friesii	Potafrie	
Potamogeton gramineus x perfoliatus (P. x nitens)	Potagram	
Potamogeton lucens	Potaluce	
Potamogeton natans	Potanata	
Potamogeton obtusifolius	Potaobtu	
Potamogeton pectinatus	Potapect	
Potamogeton perfoliatus	Potaperf	
Potamogeton polygonifolius	Potapoly	
Potamogeton pusillus	Potapusi	
Potamogeton trichoides	Potatric	
Potamogeton crispus x friesii (P. x lintonii)	Potaxlin	
Potentilla anglica	Poteangl	
Potentilla anserina	Poteanse	
Potentilla argentea	Potearge	
Potentilla erecta	Poteerec	
Potentilla fruticosa	Potefrut	
Potentilla intermedia	Poteinte	
Potentilla palustris	Potepalu	
Potentilla recta	Poterect	
Potentilla reptans	Poterept	
Potentilla sterilis	Potester	
Potentilla neumanniana	Potetabe	
Potentilla x mixta sens. lat. (P. anglica or erecta x reptans)	Potexmix	
Potentilla anglica x erecta (P. x suberecta)	Potexsub	
Pratia pedunculata	Pratpedu	
Primula elatior	Primelat	
Primula japonica	Primjapo	
Primula veris	Primveri	
Primula vulgaris	Primvulg	
Primula veris x vulgaris (P. x polyantha)	Primxpol	
Primula 'Wanda'		Deleted
Prunus avium	Prunaviu	
Prunus cerasifera	Pruncera	
Prunus cerasus	Pruncsus	
Prunus domestica	Prundome	Includes ssp. domestica, ssp. insititia & ssp. italica
Prunus dulcis	Prundulc	
Prunus laurocerasus	Prunlaur	
Prunus lusitanica	Prunlusi	
Prunus padus	Prunpadu	
Prunus persica	Prunpers	
Prunus pissardii	Prunpiss	
Prunus serotina	Prunsero	
Prunus serrulata	Prunserr	
Prunus spinosa	Prunspin	
Prunella vulgaris	Prunvulg	
Prunus domestica x spinosa (P. x fruticans)	Prunxfru	
Pseudosasa japonica	Pseujapo	
Pseudofumaria lutea	Pseulute	
Pseudotsuga menziesii	Pseumenz	
Pteridium aquilinum	Pteraqui	
Pterocarya fraxinifolia	Pterfrax	
Puccinellia distans	Puccdist	
Pulicaria dysenterica	Pulidyse	
Pulmonaria officinalis	Pulmoffi	

Pyracantha coccinea	Pyracocc	
Pyracantha rogersiana	Pyraroge	
Pyrola minor	Pyromino	
Pyrola rotundifolia ssp. rotundifolia	Pyrorotu	
Pyrus communis sens. lat.	Pyrucomm	Includes Pyrus communis sens. str. & Pyrus pyraster sens.str
Pyrus salicifolia	Pyrusali	
Quercus cerris	Quercerr	
Quercus coccinea	Quercocc	
Quercus ilex	Querilex	
Quercus palustris	Querpalu	
Quercus petraea	Querpetr	
Quercus pubescens	Querpube	
Quercus robur	Querrobu	
Quercus rubra	Querrubr	
Quercus x turneri	Querx tu	
Quercus cerris x suber (Q. x pseudosuber)	Querxcre	
Quercus petraea x robur (Q. x rosacea)	Querxros	
Ranunculus acris	Ranuacri	
Ranunculus aquatilis sens. lat.	Ranuaqua	
Ranunculus arvensis	Ranuarve	
Ranunculus auricomus	Ranuauri	
Ranunculus bulbosus	Ranubulb	Includes var.bulbosus
Ranunculus circinatus	Ranucirc	
Ranunculus ficaria ssp. ficaria	Ranufica	
Ranunculus flammula	Ranuflam	
Ranunculus fluitans	Ranuflui	
Ranunculus ficaria ssp. bulbilifer	RanufSSb	
Ranunculus hederaceus	Ranuhede	
Ranunculus lingua	Ranuling	
Ranunculus omiophyllus	Ranuomio	
Ranunculus parviflorus	Ranuparv	
Ranunculus peltatus	Ranupelt	
Ranunculus penicillatus	Ranupeni	Includes ssp. pseudofluitans
Ranunculus repens	Ranurepe	
Ranunculus retans	Ranurept	
Ranunculus sardous	Ranusard	
Ranunculus sceleratus	Ranuscel	
Ranunculus trichophyllus	Ranutric	
Raphanus raphanistrum	Raphraph	Include var. raphanistrum
Raphanus sativus	Raphsati	
Rapistrum rugosum	Rapirugo	
Reseda alba	Resealba	
Reseda luteola	Reselula	
Reseda lutea	Reselute	
Rhamnus cathartica	Rhamcath	
Rheum x hybridum (R. palmatum x rhaponticum)	Rheupalm	
Rhinanthus angustifolius	Rhinangu	
Rhinanthus minor	Rhinmino	Includes ssp. minor & ssp. stenophyllus
Rhododendron luteum	Rhodlute	
Rhododendron ponticum	Rhodpont	
Rhus typhina	Rhustyph	
Rhynchospora alba	Rhynalba	
Ribes alpinum	Ribealpi	
Ribes nigrum	Ribenigr	
Ribes rubrum	Riberubr	
Ribes sanguineum	Ribesang	
Ribes uva-crispa	Ribeuva-	
Robinia pseudoacacia	Robipseu	
Rorippa amphibia	Roriamph	
Rorippa islandica	Roriisla	
Rorippa microphylla	Rorimicr	
Rorippa nasturtium-aquaticum agg.	Rorinagg	Includes Rorippa nasturtium-aquaticum sens.str.
Rorippa palustris	Roripalu	
Rorippa sylvestris	Rorisylv	

Rorippa microphylla x nasturtium-aquaticum (R. x sterilis)	Rorixste	
Rosa arvensis	Rosaarve	
Rosa arvensis x caesia ssp. glauca	Rosaaxca	
Rosa caesia	Rosacaes	Includes ssp. caesia & ssp. glauca
Rosa canina agg.	Rosacagg	Includes Rosa canina sens.str.
Rosa caesia x obtusifolia	Rosacxob	
Rosa caesia x sherardii	Rosacxsh	
Rosa ferrugina	Rosaferr	
Rosa 'Hollandica'	RosaHoll	
Rosa luciae	Rosaluci	
Rosa mollis agg.	Rosamoll	Includes Rosa mollis sens.str.
Rosa multiflora	Rosamult	
Rosa obtusifolia	Rosaobtu	
Rosa obtusifolia x tomentosa	Rosaoxto	
Rosa rubiginosa agg.	Rosarubi	Includes Rosa rubiginosa sens.str.
Rosa rugosa	Rosarugo	
Rosa sherardii	Rosasher	
Rosa spinossima	Rosaspin	
Rosa tomentosa	Rosatome	
Rosa tomentosa x mollis	Rosatxmo	
Rosa virginiana	Rosavirg	
Ropsa x cottetii	Rosaxcot	
Rosa canina x obtusifolia (R. x dumetorum)	Rosaxdrm	
Rosa caesia x canina (R. x dumalis)	Rosaxdum	
Rosa caesia x mollis (R. x glaucoides)	Rosaxgla	
Rosa x irregularis	Rosaxirr	
Rosa canina x mollis (R. x molletorum)	Rosaxmol	
Rosa canina x rubiginosa (R. x nitidula)	Rosaxnit	
Rosa x perthensis	Rosaxper	
Rosa x rothschildii	Rosaxrot	
Rosa canina x tomentosa (R. x scabriuscula)	Rosaxsca	
Rosmarinus officinalis	Rosmoffi	
Rostraria cristata	Rostcris	
NB – Rubus species not considered to have been recorded comprehensively were deleted and have been removed to save space		
Rubus armeniacus	Rubuarme	
Rubus caesius	Rubucaes	
Rubus chamaemorus	Rubucham	
Rubus cockburnianus	Rubucock	
Rubus fruticosus agg.	Rubufrut	
Rubus idaeus	Rubuidae	
Rubus incurvatiformis	Rubuincu	
Rubus infestus	Rubuinfe	
Rubus informifolius	Rubuinfo	
Rubus insectifolius	Rubuinse	
Rubus intensior	Rubuinte	
Rubus laciniatus	Rubulaci	
Rubus odoratus	Rubuodor	
Rubus parviflorus	Rubuparv	
Rubus phoenicolasius	Rubuphoe	
Rubus saxatilis	Rubusaxa	
Rubus spectabilis	Rubuspec	
Rubus tricolor	Rubutric	
Rubus ulmifolius	Rubuulmi	
Rubus idaeus x vitifolius (R. x loganobaccus)	Rubuxlog	
Rubus ulmifolius x R. vestitus	Rubuxves	
Rudbeckia hirta	Rudbhirt	
Rumex acetosa	Rumeacet	Includes ssp. acetosa
Rumex acetosella	Rumealla	Includes ssp. acetosella & ssp. pyrenaicus
Rumex pseudoalpinus	Rumealpi	
Rumex conglomeratus	Rumecong	
Rumex crispus ssp. crispus	Rumecris	
Rumex cristatus	Rumectus	

Rumex hydrolapathum	Rumehydr	
Rumex maritimus	Rumemari	
Rumex obtusifolius	Rumeobtu	
Rumex sanguineus	Rumesang	
Rumex scutatus	Rumescut	
Rumex acetosa ssp. ambiguus	RumeSSam	
Rumex conglomeratus x obtusifolius (R. x abortivus)	Rumexabo	
Rumex obtusifolius x sanguineus (R. x dufftii)	Rumexduf	
Rumex crispus x obtusifolius (R. x pratensis)	Rumexpra	
Rumex conglomeratus x sanguineus (R. x ruhmeri)	Rumexruh	
Ruscus aculeatus	Ruscacul	
Ruscus hypoglossum	Ruschypo	
Ruta graveolens	Rutagrav	
Sagina apetala	Sagiapet	Includes ssp. apetala & ssp. erecta
Sagittaria latifolia	Sagilati	
Sagina nodosa	Saginodo	
Sagina procumbens	Sagiproc	
Sagittaria sagittifolia	Sagisagi	
Salix acutifolia	Saliacut	
Salix alba	Salialba	
Salix aurita	Saliauri	
Salix alba x babylonica (S. x sepulcralis)	Salixbaby	Includes Salix babylonica
Salix caprea	Salicapr	
Salix cinerea		Deleted, segregates retained
Salix cinerea ssp. oleifolia	Salicine	
Salix cinerea ssp. cinerea	SalicSSc	
Salix daphnoides	Salidaph	
Salix elaeagnos	Salielae	
Salix fragilis	Salifrag	
Salix pentandra	Salipent	
Salix purpurea	Salipurp	
Salix purpurea x viminalis (S. x rubra)	Salipxvi	
Salix repens	Salirepe	
Salix triandra	Salitria	
Salix viminalis	Salivimi	
Salix x calodendron (S. caprea x cinerea x viminalis)	Salixcal	
Salix x forbyana (S. cinerea x purpurea x viminalis)	Salixfor	
Salix x holosericea	Salixhol	
Salix fragilis x pentandra (S. x meyeriana)	Salixmey	
Salix triandra x viminalis (S. x mollissima)	Salixmol	
Salix aurita x cinerea (S. x multinervis)	Salixmul	
Salix babylonica x fragilis (S. x pendulina)	Salixpen	
Salix caprea x cinerea (S. x reichardtii)	Salixrei	
Salix alba x fragilis (S. x rubens)	Salixrub	
Salix cinerea x viminalis (S. x smithiana)	Salixsmi	
Salvia officinalis	Salvoffi	
Salvia pratensis	Salvprat	
Salvia sclarea	Salvscla	
Salvia splendens	Salvsple	
Salvia verbenaca	Salvverb	
Salvia verticillata	Salvvert	
Sambucus canadensis	Sambcana	
Sambucus ebulus	Sambebul	
Sambucus nigra	Sambnigr	Includes vars `Aurea', laciniata & viridis
Sambucus nigra	SambnAur	
Sambucus racemosa	Sambrace	
Samolus valerandi	Samovale	
Sanguisorba minor		Deleted
Sanguisorba minor ssp. minor	Sangmmin	
Sanguisorba minor ssp. muricata	Sangmmur	
Sanguisorba officinalis	Sangoffi	
Sanicula europaea	Sanieuro	
Saponaria ocymoides	Sapoocym	
Saponaria officinalis	Sapooffi	

Sasa palmata	Sasapalm	
Sasaella ramosa	Sasaramo	
Sasa veitchii	Sasaveit	
Saxifraga cuneifolia	Saxicune	
Saxifraga cymbalaria	Saxicymb	
Saxifraga granulata	Saxigran	
Saxifraga hypnoides	Saxihypn	
Saxifraga spathularis	Saxispat	
Saxifraga tridactylites	Saxitrid	
Saxifraga umbrosa	Saxiumbr	
Saxifraga spathularis x umbrosa (S. x urbium)	Saxixurb	
Scabiosa columbaria	Scabcolu	
Schoenoplectus lacustris	Scholacu	
Schoenoplectus tabernaemontani	Schotabe	
Scilla siberica	Scilsibe	
Scirpus sylvaticus	Scirsylv	
Scleranthus annuus	Scleannu	
Scorzonera hispanica	Scorhisp	
Scrophularia auriculata	Scroauri	
Scrophularia nodosa	Scronodo	
Scrophularia umbrosa	Scroumbr	
Scutellaria galericulata	Scutgale	
Scutellaria minor	Scutmino	
Secale cereale	Secacere	
Securigera varia	Secuvari	
Sedum acre	Seduacre	
Sedum album	Sedualbu	
Sedum forsterianum	Sedufors	
Sedum rupestre	Sedurupe	
Sedum saxatile	Sedusaxa	
Sedum sexangulare	Sedusexa	
Sedum spathulifolium	Seduspat	
Sedum spectabile	Seduspec	
Sedum spurium	Seduspur	
Sedum `Herbstfreude'	Sedusxte	
Sedum telephium	Sedutele	Includes ssp. fabaria & ssp. telephium
Sedum album ssp. album	SeduaSal	
Selaginella kraussiana	Selakrau	
Sempervivum tectorum	Semptect	
Senecio aquaticus	Seneaqua	
Senecio cineraria	Senecine	
Senecio erucifolius	Seneeruc	
Senecio inaequidens	Seneinae	
Senecio jacobaea	Senejaco	
Senecio squalidus	Senesqua	
Senecio sylvaticus	Senesylv	
Senecio viscosus	Senevisc	
Senecio vulgaris	Senevulg	Includes var. hibernicus & var. vulgaris
Senecio cineraria x jacobaea (S. x albescens)	Senexalb	
Senecio squalidus x vulgaris (S. x baxteri)	Senexbax	
Senecio aquaticus x jacobaea (S. x ostenfeldii)	Senexost	
Senecio squalidus x viscosus (S. x subnebrodensis)	Senexsub	
Sequoia sempervirens	Sequsemp	Record deleted – arboretum single record
Sequoiadendron giganteum	Sequgiga	Record deleted – arboretum single record
Serratula tinctoria	Serrtinc	
Setaria italica	Setaital	
Setaria pumila	Setapumi	
Setaria verticillata	Setavert	
Setaria viridis	Setaviri	
Sherardia arvensis	Sherarve	
Sibthorpia europaea	Sibteuro	
Sidalcea malvaeflora	Sidamalv	
Sigesbeckia serrata	Sigeserr	
Silaum silaus	Silasila	

Silene dioica	Siledioi	
Silene latifolia	Silelati	
Silene noctiflora	Silenoct	
Silene nutans	Silenuta	
Silene otites	Sileotit	
Silene uniflora	Sileunif	
Silene vulgaris	Silevulg	
Silene dioica x latifolia (S. x hampeana)	Silexham	
Silybum marianum	Silymari	
Sinapis alba	Sinaalba	
Sinapis arvensis	Sinaarve	
Sison amomum	Sisoamom	
Sisymbrium altissimum	Sisyalti	
Sisyrinchium bermudiana	Sisyberm	
Sisyrinchium californicum	Sisycali	
Sisymbrium loeselii	Sisyloes	
Sisyrinchium montanum	Sisymont	
Sisymbrium officinale	Sisyoffi	
Sisymbrium orientale	Sisyorie	
Sisymbrium polyceratium	Sisypoly	
Sisyrinchium striatum	Sisystri	
Skimmia japonica	Skimjapo	
Smyrnium olusatrum	Smyrolus	
Solanum dulcamara	Soladulc	
Solanum nigrum	Solanigr	IncludesSolanum nigrum ssp. nigrum
Solanum physalifolium	Solaphys	
Solanum rostratum	Solarost	
Solanum scabrum	Solascab	
Solanum tuberosum	Solatube	
Solanum villosum	Solavill	
Soleirolia soleirolii	Solesole	
Solidago canadensis	Solicana	
Solidago gigantea	Soligiga	
Solidago virgaurea	Solivirg	
Sonchus arvensis	Soncarve	
Sonchus asper	Soncaspe	
Sonchus oleraceus	Soncoler	
Sorbus aria agg.	Sorbaria	Includes Sorbus aria sens.str
Sorbus aucuparia	Sorbaucu	
Sorbus croceocarpa	Sorbcroc	
Sorbus domestica	Sorbdome	
Sorbus hupehensis	Sorbhupe	
Sorbus hybrida	Sorbhybr	
Sorbus intermedia agg.	Sorbinte	Includes Sorbus intermedia sens.str
Sorbaria kirilowii	Sorbkiri	
Sorbus latifolia sens.str.	Sorblati	
Sorbusrupicola	Sorbrupi	
Sorbus thibetica	Sorbthib	
Sorbus 'Joseph Rock'		Record deleted – arboretum single record
Sorbaria tomentosa	Sorbtome	
Sorbus torminalis	Sorbtorm	
Sorbus aria x aucuparia (S. x thuringiaca)	Sorbxthu	
Sparganium emersum	Sparemer	
Sparganium erectum	Sparerec	Includes all subspecies
Spartium junceum	Sparjunc	
Spergula arvensis	Sperarve	
Spergularia marina	Spermari	
Spergularia rubra	Sperrubr	
Spinacia oleracea	Spinoler	
Spirodela polyrhiza	Spirpoly	
Spiraea sp.	Spirsp.	Includes all hybrids and cultivars
Stachys arvensis	Stacarve	
Stachys byzantina	Stacbyza	
Stachys officinalis	Stacoffi	

Stachys palustris	Stacpalu	
Stachys sylvatica	Stacsylv	
Stachys palustris x sylvatica (S. x ambigua)	Stacxamb	
Stellaria uliginosa	Stelalsi	
Stellaria graminea	Stelgram	
Stellaria holostea	Stelholo	
Stellaria media	Stelmedi	
Stellaria neglecta	Stelnegl	
Stellaria nemorum ssp. nemorum	Stelnemo	
Stellaria pallida	Stelpall	
Stellaria palustris	Stelpalu	
Stratiotes aloides	Straaloi	
Succisa pratensis	Succprat	
Symphoricarpos albus	Sympalbu	
Symphytum asperum	Sympaspe	
Symphytum grandiflorum	Sympgran	
Symphytum 'Hidcote Blue' (S. asperum x grandiflorum x officinale)	SympHidc	
Symphoricarpos microphyllus x orbicularis (S. x chenaultii)	Sympmicr	
Symphytum officinale	Sympoffi	
Symphytum orientale	Symporie	
Symphytum tuberosum	Symptube	
Symphytum asperum x officinale (S. x uplandicum)	Sympxupl	
Syringa vulgaris	Syrivulg	
Tagetes erecta	Tageerec	
Tagetes patula	Tagepatu	
Tamarix gallica	Tamagall	
Tamus communis	Tamucomm	
Tanacetum parthenium	Tanapart	
Tanacetum vulgare	Tanavulg	
Taraxacum officinale agg.	Taraoffi	Includes all segregates
Taxus baccata	Taxubacc	
Telekia speciosa	Telespec	
Tellima grandiflora	Tellgran	
Teucrium chamaedrys	Teuccham	
Teucrium scorodonia	Teucscor	
Teucrium scordium	Teucscum	
Thalictrum flavum	Thalflav	
Thalictrum lucidum	Thalluci	
Thalictrum minus	Thalminu	
Thelypteris palustris	Thelpalu	
Thlaspi alliacium	Thlaalli	
Thlaspi arvense	Thlaarve	
Thuja occidentalis	Thujocci	
Thuja plicata	Thujplic	
Thymus polytrichus	Thympoly	
Thymus vulgaris	Thymvulg	
Tilia cordata	Tilicord	
Tilia 'Petiolaris'	Tili.Pet	
Tilia platyphyllos	Tiliplat	
Tilia tomentosa	Tilitome	
Tilia x euchlora	Tilixeuc	
Tilia cordata x platyphyllos (T. x vulgaris)	Tilixeur	
Tolmiea menziesii	Tolmmenz	
Torilis japonica	Torijapo	
Trachystemon orientalis	Tracorie	
Tradescantia virginiana	Tradvirg	
Tragopogon porrifolius	Tragporr	
Tragopogon pratensis	Tragprat	Includes ssp. minor & ssp. pratensis
Trichophorum cespitosum	Triccesp	
Trifolium alexandrinum	Trifalex	
Trifolium arvense	Trifarve	

Trifolium campestre	Trifcamp	
Trifolium dubium	Trifdubi	
Trifolium fragiferum	Triffrag	
Trifolium hybridum	Trifhybr	
Trifolium incarnatum ssp. incarnatum	Trifinca	
Trifolium medium	Trifmedi	
Trifolium micranthum	Trifmicr	
Trifolium pratense	Trifprat	
Trifolium repens	Trifrepe	
Trifolium resupinatum	Trifresu	
Trifolium scabrum	Trifscab	
Trifolium striatum	Trifstri	
Trifolium subterraneum	Trifsubt	
Trigonella foenum-graecum	Trigfoen	
Triglochin maritimum	Trigmari	
Triglochin palustre	Trigpalu	
Tripleurospermum inodorum	Tripinod	
Trisetum flavescens	Trisflav	
Triticum aestivum	Tritaest	
Triticum turgidum	Tritturg	
Trollius europaeus	Troleuro	
Tropaeolum majus	Tropmaju	
Tsuga canadensis	Tsugcana	
Tsuga heterophylla	Tsughete	
Tulipa gesneriana	Tuligesn	
Tulipa saxatilis	Tulisaxa	
Tulipa sylvestris	Tulisylv	
Tussilago farfara	Tussfarf	
Typha angustifolia	Typhangu	
Typha latifolia	Typhlati	
Typha angustifolia x latifolia (T. x glauca)	Typhxgla	
Ulex europaeus	Ulexeuro	
Ulex gallii	Ulexgall	
Ulex minor	Ulexmino	
Ulmus glabra	Ulmuglab	
Ulmus minor ssp. minor	Ulmummin	
Ulmus minor ssp. sarniensis	Ulmumsar	
Ulmus plotii	Ulmuplot	
Ulmus procera	Ulmuproc	
Ulmus x hollandica (U. glabra x minor x plotii)	Ulmuxhol	
Ulmus x vegeta (U. glabra x minor)	Ulmuxveg	
Ulmus minor x plotii (U. x viminalis)	Ulmuxvim	
Umbilicus rupestris	Umbirupe	
Urtica dioica ssp. galeopsifolia	Urtidgal	
Urtica dioica	Urtidioi	
Urtica urens	Urtiuren	
Vaccaria hispanica	Vacchisp	
Vaccinium myrtillus	Vaccmyrt	
Vaccinium oxycoccos	Vaccoxyc	
Vaccinium vitis-idaea	Vaccviti	
Vaccinium myrtillus x vitis-idaea (V. x intermedium)	Vaccxint	
Valerianella carinata	Valecari	
Valeriana dioica	Valedioi	
Valerianella locusta	Valelocu	
Valeriana officinalis	Valeoffi	
Valeriana pyrenaica	Valepyre	
Verbascum blattaria	Verbblat	
Verbena bonariensis	Verbbona	
Verbascum densiflorum	Verbdens	
Verbascum lychnitis	Verblych	
Verbascum nigrum	Verbnigr	
Verbena officinalis	Verboffi	
Verbascum phlomoides	Verbphlo	

Verbascum speciosum	Verbspec	
Verbascum thapsus	Verbthap	
Verbascum virgatum	Verbvirg	
Veronica agrestis	Veroagre	
Veronica anagallis-aquatica	Veroanag	
Veronica arvensis	Veroarve	
Veronica beccabunga	Verobecc	
Veronica catenata	Verocate	
Veronica chamaedrys	Verocham	
Veronica filiformis	Verofili	
Veronica hederifolia	Verohede	Includes ssp. hederifolia & ssp. lucorum
Veronica longifolia	Verolong	
Veronica montana	Veromont	
Veronica officinalis	Verooffi	
Veronica persica	Veropers	
Veronica polita	Veropoli	
Veronica scutellata	Veroscut	
Veronica serpyllifolia	Veroserp	
Veronica spicata	Verospic	
Viburnum lantana	Vibulant	
Viburnum opulus	Vibuopul	
Viburnum rhytidophyllum	Viburhyt	
Viburnum tinus	Vibutinu	
Viburnum trilobum	Vibutril	
Vicia bithynica	Vicibith	
Vicia cracca	Vicicrac	
Vicia faba	Vicifaba	
Vicia hirsuta	Vicihirs	
Vicia sepium	Vicisepi	
Vicia sativa ssp. nigra	Vicisnig	
Vicia sativa ssp. sativa	Vicissat	
Vicia sativa ssp. segetalis	Vicisseg	
Vicia sylvatica	Vicisylv	
Vicia tenuifolia	Vicitenu	
Vicia tetrasperma	Vicitetr	
Vicia villosa	Vicivill	
Vinca major	Vincmajo	
Vinca minor	Vincmino	
Viola arvensis	Violarve	
Viola canina	Violcani	
Viola hirta	Violhirt	
Viola labradorica	Viollabr	
Viola lutea	Viollute	
Viola odorata	Violodor	
Viola palustris	Violpalu	
Viola reichenbachiana	Violreic	
Viola riviniana	Violrivi	
Viola tricolor	Violtric	
Viola x bavarica	Violxbav	
Viola x wittrockiana	Violxwit	
Viscum album	Viscalbu	
Vitis vinifera	Vitivini	
Vulpia bromoides	Vulpbrom	
Vulpia myuros	Vulpmyur	
Wahlenbergia hederacea	Wahlhede	
Weigela florida	Weigflor	
Xanthocyparis nootkatensis	Xantnoot	
Zannichellia palustris	Zannpalu	
Zantedeschia aethiopica	Zantaeth	
Zea mays	Zeamays	

APPENDIX B - ENVIRONMENTAL VARIABLES EDITING & ABBREVIATION

Variable	Source	Data used	Abbreviation	Type	Further category (if used)
18th and 19th Century enclosure	Staffordshire County Council	Tetrad values in hectares	18th19th	Historic field system	
Acid brown soils	Flora of Staffordshire (Edees 1972)(digitised)	Total for tetrad in hectares	Acid bro	Soils	
Agricultural land	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	Agricult	Land cover	
Allotments	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares; usually clearly indicated as allotments on maps, cross-checked with aerial photographs	Allotmen	Land cover	Built development
Alluvium	Adapted from British Geological Survey digital map	Total for tetrad in hectares	ALLUVIUM	Drift geology	
Ancient replanted woods	As Ancient Woodland	Total for tetrad in hectares	AncientR	Nature conservation	
Ancient woodland	Tetrad areas calculated using data from Ancient Woodland Inventory	Total for tetrad in hectares	AncientW	Nature conservation	
Average field size	Ordnance Survey Explorer 1:25,000 maps	Area of agricultural land divided by number of fields = average field size in hectares	AvField		
Canals	Ordnance Survey Explorer 1:25,000 maps	Estimated length (metres)	Canal	Linear	Built development
Coal measures	(Edees 1972) (adapted with advice from Staffordshire Regionally Important Geological and Geomorphological Sites Group and using data from British Geological Survey digital map data)	Total for tetrad in hectares	Coal Mea	Geology	
Commercial land	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares of shopping centres and similar land.	Commerci	Land cover	Linear
Conifer woods	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	ConiferW	Land cover	
Deciduous woods	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	Deciduou	Land cover	
Difference in altitude	Ordnance Survey Explorer 1:25,000 maps	Difference between max and min for tetrad (metres)	AltDiff	Geographical	

Disused railway	Ordnance Survey Explorer 1:25,000 maps	Estimated length (metres)	DisusedR	Linear	Built development
Drift unspecific	As Alluvium	Total for tetrad in hectares	DRIFT GE	Drift geology	
Early assarts	Staffordshire County Council	Tetrad values in hectares	EarlyAss	Historic field system	
Early small irregular fields	Staffordshire County Council	Tetrad values in hectares	ESIF	Historic field system	
Early small rectilinear fields	Staffordshire County Council	Tetrad values in hectares	ESRF	Historic field system	
East	Ordnance Survey Explorer 1:25,000 maps	10 km distance from eastern boundary of vice-county	East	Geographical	
Glacial	As Alluvium	Total for tetrad in hectares	GLACIAL	Drift geology	
Gleys	Edees (digitised)	Total for tetrad in hectares	Gleys	Soils	
Golf courses	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares; usually clearly indicated as golf courses on maps, cross-checked with aerial photograph	Golf	Land cover	
Greenspace	Ordnance Survey Explorer 1:25,000 maps	Estimated cover ha, cross-checked with aerial photographs. Urban land apparently under agricultural management was classed as 'agricultural'	Greenspa	Land cover	Built development
Ground frost	Met Office (adapted)	Annual average days ground frost	GroundFr	Climate	
Heathland	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares of heathland areas shown on map	Heath	Land cover	
Igneous geology	As Coal Measures	Total for tetrad in hectares for each type	Igneous	Geology	
Industrial land	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares, usually indicated as 'works' on maps.	Industri	Land cover	Built development
Keuper marl	As Coal Measures	Total for tetrad in hectares	Keuper m	Geology	
Landslip	As Alluvium	Total for tetrad in hectares	LANDSLIP	Drift geology	
Leached brown and gley soils	Edees (digitised)	Total for tetrad in hectares	Leach B & gleys	Soils	
Leached brown soils	Edees (digitised)	Total for tetrad in hectares	Leached	Soils	
Limestone	As Coal Measures	Total for tetrad in hectares for each type	Limeston	Geology	
Site of Biological Importance	Tetrad areas calculated using data from site boundaries	Total for tetrad in hectares	SINC SBI	Nature conservation	
Major roads	Ordnance Survey	Estimated length	MajorRo a	Linear	Built

	Explorer 1:25,000 maps	(metres)			development
Max temp	Met Office (adapted)	Annual average range	MaxTemp	Climate	
Maximum altitude	Ordnance Survey Explorer 1:25,000 maps	Maximum value recorded for each tetrad (metres)	MaxOfAlt	Geographical	
Mean Temperature	Met Office (adapted)	Annual average range	MeanTe mp	Climate	
Millstone grit	As Coal Measures	Total for tetrad in hectares	Millston	Geology	
Minimum altitude	Ordnance Survey Explorer 1:25,000 maps	Minimum for tetrad was subtracted from 600 (metres)	Minimum	Geographical	
Minimum temperature	Met Office (adapted)	Annual average range	Min Temp	Climate	
Miscellaneous floodplain fields	Staffordshire County Council	Tetrad values in hectares	MFF	Historic field system	
Mixed woods	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	MixedW	Land cover	
No drift	As Alluvium	Total for tetrad in hectares	NoDrift	Drift geology	
North	Ordnance Survey Explorer 1:25,000 maps	10 km distance from southern boundary of vice-county	North	Geographical	
Number of species	Access database	Count	Species		
Open moorland	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares of enclosed moorland	OpenMoor	Land cover	
Open water	Tetrad areas calculated using data from OS Mastermap	Total for tetrad in hectares	OpenWate	Land cover	
Orchards	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	Orchard	Land cover	
Other roads	Ordnance Survey Explorer 1:25,000 maps	Estimated length (metres)	Roads	Linear	Built development
Paddocks	Staffordshire County Council	Tetrad values in hectares	Paddocks	Historic field system	
Parkland	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares of parkland, usually associated with large houses and shown as scattered trees	Parkland	Land cover	
Peat	As Alluvium	Total for tetrad in hectares	PEAT	Drift geology	
Peaty gleys	Edees (digitised)	Total for tetrad in hectares	Peaty gl	Soils	
Piecemeal enclosure	Staffordshire County Council	Tetrad values in hectares	Piece	Historic field system	
Plant nurseries	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	PlantNur	Land cover	
Podzolised acid brown	Edees (digitised)	Total for tetrad in hectares		Soils	
Podzols	Edees (digitised)	Total for tetrad in hectares	Podzols	Soils	
Podzols and acid brown soils	Edees (digitised)	Total for tetrad in hectares	Podz & AB	Soils	
Post 1880	Staffordshire County	Tetrad values in	Post1880	Historic field	

enclosure	Council	hectares		system	
Quarries	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	Quarry	Land cover	Built development
Railway	Ordnance Survey Explorer 1:25,000 maps	Estimated length (metres)	Railway	Linear	Built development
Rainfall	Met Office (adapted)	Annual average range in mm	Rainfall	Climate	
Residential	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares, built up land, other than industrial or commercial and including gardens	Resident	Land cover	Built development
River terraces	As Alluvium	Total for tetrad in hectares	RIVER TE	Drift geology	
Rivers	Ordnance Survey Explorer 1:25,000 maps	Estimated length (metres)	River	Linear	
Sites of Special Scientific Interest	Tetrad areas calculated using data from site boundaries	Total for tetrad in hectares	SSSIs	Nature conservation	
Snow	Met Office (adapted)	Annual average no if days snow lie	Snow	Climate	
Sunshine	Met Office (adapted)	Annual average hours	Sunshine	Climate	
Till	As Alluvium	Total for tetrad in hectares	TILL	Drift geology	
Tips	Ordnance Survey Explorer 1:25,000 maps	Estimated cover hectares	Tip	Land cover	Built development
Triassic	As Coal Measures	Total for tetrad in hectares	Triassic	Geology	

APPENDIX C – TWINSPAN RESULTS

Input data file :
Title : This table created by merging 10 tables. 873 samples,1840 variables
Format : (I5,1X,8F9.5,229(/6X,(8F9.5)))

Number of samples 873

Number of species 1840

End of list of omissions
Minimum group size for division: 5 Maximum number of indicators per division: 7
Maximum number of species in final tabulation: 100 Maximum level of divisions: 6
Machine readable copy is wanted Weights for levels of pseudospecies: 1.0000
Indicator potentials for cut levels: 1
Species omitted from the list of potential indicators End of list of omissions

Length of data array after defining pseudospecies 231035
Total number of species and pseudospecies 1819
Number of species,excluding pseudospecies and ones with no occurrences 1819
Sample weights:
Species weights:

****
****

DIVISION 1 (N= 813) I.E. GROUP *
Eigenvalue 0.103 at iteration 3
INDICATORS,together with their SIGN
Lact serr1(-) Hord muri1(-) Oxal acet1(+) Armo rust1(-) Malv sylv1(-) Papa rhoe1(-)
Maximum indicator score for negative group -3 Minimum indicator score for positive group -2

Items in NEGATIVE group 2 (N= 390) i.e.

group *0

SJ71R SJ71S SJ71U SJ71V SJ71W SJ71X SJ71Z SJ72H SJ72K SJ72N SJ72R SJ72T
SJ72V SJ72W SJ75V SJ80G SJ80J SJ80K SJ80L SJ80M SJ80Q SJ80R SJ80S SJ80U
SJ80V SJ80W SJ80X SJ80Y SJ80Z SJ81B SJ81F SJ81N SJ81R SJ81S SJ81W SJ81X
SJ81Z SJ82C SJ82F SJ82G SJ82P SJ82Q SJ82R SJ82S SJ82T SJ82V SJ82W SJ82X
SJ82Y SJ83F SJ83L SJ83T SJ83X SJ84D SJ84I SJ84J SJ84N SJ84P SJ84Q SJ84S
SJ84T SJ84U SJ84W SJ84X SJ84Y SJ85F SJ85K SJ85L SJ85M SJ85Q SJ85V SJ90A
SJ90B SJ90C SJ90D SJ90E SJ90F SJ90G SJ90H SJ90I SJ90J SJ90K SJ90L SJ90M
SJ90N SJ90P SJ90Q SJ90R SJ90S SJ90T SJ90U SJ90V SJ90W SJ90X SJ90Y SJ90Z
SJ91A SJ91B SJ91C SJ91D SJ91E SJ91F SJ91G SJ91H SJ91I SJ91J SJ91L SJ91P
SJ91Q SJ91R SJ91V SJ91W SJ92A SJ92B SJ92C SJ92D SJ92F SJ92G SJ92H SJ92I
SJ92K SJ92L SJ92N SJ92Q SJ92R SJ92T SJ92X SJ92Y SJ93A SJ93B SJ94B SJ94C
SJ94G SJ94K SK00A SK00B SK00C SK00D SK00E SK00F SK00G SK00H SK00I SK00J
SK00K SK00L SK00M SK00N SK00P SK00Q SK00R SK00S SK00T SK00U SK00V SK00W
SK00X SK00Y SK01A SK01B SK01F SK01G SK01H SK01J SK01M SK01N SK01P SK01T
SK01U SK01V SK01Y SK01Z SK02A SK02B SK02D SK02F SK02K SK02Q SK02R SK02W
SK02X SK03W SK03X SK10A SK10B SK10C SK10D SK10E SK10F SK10G SK10H SK10I
SK10J SK10K SK10L SK10M SK10N SK10P SK10Q SK10R SK10S SK10T SK10U SK10V
SK10W SK10X SK10Y SK10Z SK11A SK11B SK11C SK11D SK11F SK11G SK11H SK11I
SK11J SK11K SK11L SK11M SK11N SK11P SK11Q SK11R SK11S SK11T SK11U SK11V
SK11W SK11X SK11Y SK11Z SK12A SK12F SK12H SK12K SK12P SK12Q SK12S SK12V
SK12Z SK13A SK13B SK13K SK13Q SK20A SK20B SK20C SK20D SK20E SK20F SK20G
SK20H SK20I SK20M SK20P SK21A SK21B SK21D SK21E SK21F SK21G SK21K SK21Q
SK22A SK22B SK22D SK22E SK22F SK22G SK22H SK22I SK22J SK22K SK22L SK22M
SK22N SK22R SK22S SK22T SO78Q SO78V SO78Y SO78Z SO79Z SO88D SO88E SO88H
SO88I SO88J SO88L SO88M SO88N SO88P SO88Q SO88R SO88S SO88T SO88U SO88V

SO88X SO88Y SO88Z SO89E SO89F SO89G SO89H SO89I SO89J SO89K SO89L SO89M
SO89N SO89P SO89Q SO89R SO89S SO89T SO89U SO89V SO89W SO89X SO89Y SO89Z
SO98C SO98D SO98E SO98H SO98I SO98J SO98M SO98N SO98P SO98T SO98U SO99A
SO99B SO99C SO99D SO99E SO99F SO99G SO99H SO99I SO99J SO99K SO99L SO99M
SO99N SO99P SO99Q SO99R SO99S SO99T SO99U SO99V SO99W SO99X SO99Y SO99Z
SP08C SP08E SP08G SP08H SP08I SP08J SP08P SP09A SP09B SP09C SP09D SP09E
SP09F SP09G SP09H SP09I SP09J SP09K SP09L SP09M SP09N SP09P SP09Q SP09R
SP09S SP09T SP09U SP09X SP19Z SP29E

BORDERLINE negatives (N= 105)
SJ71R SJ71U SJ71W SJ71X SJ71Z SJ72H SJ72N SJ72T SJ72V SJ72W SJ80G SJ80J
SJ80M SJ80U SJ80Y SJ81B SJ81F SJ81R SJ81S SJ81W SJ81Z SJ82C SJ82G SJ82P
SJ82Q SJ82R SJ82S SJ82T SJ82V SJ82W SJ83F SJ83L SJ83T SJ84Q SJ90G SJ91D
SJ91L SJ91P SJ92A SJ92D SJ92L SJ92N SJ92Q SJ92R SJ92T SJ93A SJ94C SJ94K
SK00C SK00D SK00E SK00W SK01F SK01G SK01H SK01M SK01T SK01U SK01V SK01Z
SK02A SK02B SK02D SK02F SK02Q SK02R SK02W SK02X SK10F SK10G SK10K SK10P
SK10T SK11G SK11P SK11Q SK11U SK12A SK12F SK12H SK12K SK12P SK12Q SK12Z
SK13A SK13B SK20I SK20M SK21G SK21Q SK22B SK22J SO78Z SO79Z SO88D SO88E
SO88H SO88I SO88J SO88N SO89F SO89I SO99C SP08C SP09N

MISCLASSIFIED negatives (N= 5)
SJ84N SJ84P SJ85M SJ90S SP08H

Items in POSITIVE group 3 (N= 423) i.e.
group *1
SJ63R SJ63W SJ63X SJ70V SJ71Q SJ71Y SJ72I SJ72L SJ72M SJ72P SJ72Q SJ72S
SJ72U SJ72X SJ72Y SJ72Z SJ73B SJ73C SJ73D SJ73E SJ73G SJ73H SJ73I SJ73J
SJ73K SJ73L SJ73M SJ73N SJ73P SJ73Q SJ73R SJ73S SJ73T SJ73U SJ73V SJ73W
SJ73X SJ73Y SJ73Z SJ74K SJ74L SJ74M SJ74N SJ74P SJ74Q SJ74R SJ74S SJ74T
SJ74U SJ74V SJ74W SJ74X SJ74Y SJ74Z SJ75K SJ75Q SJ75W SJ80A SJ80E SJ80F
SJ80N SJ80P SJ80T SJ81A SJ81C SJ81D SJ81E SJ81G SJ81H SJ81I SJ81J SJ81K
SJ81L SJ81M SJ81P SJ81Q SJ81T SJ81U SJ81V SJ81Y SJ82A SJ82B SJ82D SJ82E
SJ82H SJ82I SJ82J SJ82K SJ82L SJ82M SJ82N SJ82U SJ82Z SJ83A SJ83B SJ83C
SJ83D SJ83E SJ83G SJ83H SJ83I SJ83J SJ83K SJ83M SJ83N SJ83P SJ83Q SJ83R
SJ83S SJ83U SJ83V SJ83W SJ83Y SJ83Z SJ84A SJ84B SJ84C SJ84E SJ84F SJ84G
SJ84H SJ84K SJ84L SJ84M SJ84R SJ84V SJ84Z SJ85A SJ85B SJ85G SJ85H SJ85N
SJ85R SJ85S SJ85T SJ85U SJ85W SJ85X SJ85Y SJ85Z SJ86V SJ91K SJ91M SJ91N
SJ91S SJ91T SJ91U SJ91X SJ91Y SJ91Z SJ92E SJ92J SJ92M SJ92P SJ92S SJ92U
SJ92V SJ92W SJ92Z SJ93C SJ93D SJ93E SJ93F SJ93G SJ93H SJ93I SJ93J SJ93K
SJ93L SJ93M SJ93N SJ93P SJ93Q SJ93R SJ93S SJ93T SJ93U SJ93V SJ93W SJ93X
SJ93Y SJ93Z SJ94A SJ94D SJ94E SJ94F SJ94H SJ94I SJ94J SJ94L SJ94M SJ94N
SJ94P SJ94Q SJ94R SJ94S SJ94T SJ94U SJ94V SJ94W SJ94X SJ94Y SJ94Z SJ95A
SJ95B SJ95C SJ95D SJ95E SJ95F SJ95G SJ95H SJ95I SJ95J SJ95K SJ95L SJ95M
SJ95N SJ95P SJ95Q SJ95R SJ95S SJ95T SJ95U SJ95V SJ95W SJ95X SJ95Y SJ95Z
SJ96A SJ96B SJ96C SJ96F SJ96G SJ96K SJ96L SJ96Q SJ96R SJ96S SJ96V SJ96W
SJ96X SK00Z SK01C SK01D SK01E SK01I SK01K SK01L SK01Q SK01R SK01S SK01W
SK01X SK02C SK02E SK02G SK02H SK02I SK02J SK02L SK02M SK02N SK02P SK02S
SK02T SK02U SK02V SK02Y SK02Z SK03A SK03B SK03C SK03D SK03E SK03F SK03G
SK03H SK03I SK03J SK03K SK03L SK03M SK03N SK03P SK03Q SK03R SK03S SK03T
SK03U SK03V SK03Y SK03Z SK04A SK04B SK04C SK04D SK04E SK04F SK04G SK04H
SK04I SK04J SK04K SK04L SK04M SK04N SK04P SK04Q SK04R SK04S SK04T SK04U
SK04V SK04W SK04X SK04Y SK04Z SK05A SK05B SK05C SK05D SK05E SK05F SK05G
SK05H SK05I SK05J SK05K SK05L SK05M SK05N SK05P SK05Q SK05R SK05S SK05T
SK05U SK05V SK05W SK05X SK05Y SK05Z SK06A SK06B SK06C SK06D SK06F SK06G
SK06H SK06I SK06J SK06K SK06L SK06M SK06N SK06Q SK06R SK06S SK06T SK06V
SK06W SK06X SK11E SK12B SK12C SK12D SK12E SK12G SK12I SK12J SK12L SK12M
SK12N SK12R SK12T SK12U SK12W SK12X SK12Y SK13C SK13E SK13F SK14A SK14B
SK14C SK14D SK14E SK14G SK14H SK14I SK14J SK14M SK14N SK14P SK15A SK15B
SK15C SK15D SK15E SK15F SK15G SK15H SK15I SK15J SK15K SK16A SK16B SK20J
SK20N SK20U SK21C SK22C SO77P SO77U SO78K SO78W SO88B SO88C SO88G SO89A
SP09Z SP19P SP19U

BORDERLINE positives (N= 77)
SJ71Q SJ71Y SJ72L SJ72M SJ72P SJ72S SJ72U SJ72Y SJ73C SJ74K SJ74N SJ80F
SJ80N SJ80P SJ80T SJ81C SJ81D SJ81I SJ81J SJ81M SJ81Q SJ81T SJ81U SJ81V
SJ82D SJ83M SJ83R SJ83U SJ83V SJ83W SJ83Z SJ84M SJ84R SJ84V SJ84Z SJ85G

SJ85H SJ85R SJ85S SJ91K SJ91N SJ91T SJ92E SJ92M SJ92P SJ92S SJ92V SJ92W
SJ93F SJ94F SJ94H SJ94Q SK00Z SK01I SK01W SK01X SK02C SK02I SK02S SK11E
SK12C SK12R SK12W SK12X SK12Y SK13C SK13E SK13F SK20J SK20N SK20U SK21C
SO78K SO88G SO89A SP09Z SP19P

MISCLASSIFIED positives (N= 18)
SJ81G SJ81L SJ82A SJ82Z SJ91M SJ91U SJ92U SK02G SK02M SK02U SK02V SK03C
SK03R SK03S SK05Q SK12M SK12T SK22C

NEGATIVE PREFERENTIALS
Verb thap1(185,71) Vici tetr1(103,28) Vinc majo1(79,29) Viol xwit1(89,25) Vulp brom1(136,36) Vulp myur1(154,31) Aeth cyna1(292,117) Alnu inca1(119,59) Anag arve1(288,132) Anch arve1(146,32) Anti maju1(83,17) Apha arve1(114,55)
Aqui vulg1(103,48) Armo rust1(351,116) Arte absi1(240,50) Aven sati1(126,54) Ball nigr1(242,76) Bryo dioi1(214,41) Budd davi1(213,81) Buto umbe1(81,7)
Card nuta1(117,57) Care otru1(182,61) Cent rube1(101,32) Coch dani1(225,98)
Coni macu1(197,68) Conv arve1(295,105) Cony cana1(262,69) Coro didy1(183,45) Crep vesi1(183,27) Dauc caro1(146,25) Dips full1(267,135) Erod cicu1(166,31) Foen vulg1(115,12) Fuma offi1(256,76) Gera pusi1(220,50) Gera pyre1(151,41)
Hord dist1(87,38) Hord muri1(330,74) Hype perf1(316,154) Impa cape1(95,30) Labu anag1(118,27) Lact serr1(340,81) Lact viro1(82,10) Lami ampl1(125,22) Lina purp1(186,46) Lina vulg1(214,70) Lobu mari1(78,9) Lupi xreg1(88,17)
Lyth sali1(96,39) Malv mosc1(196,79) Malv negl1(83,27) Malv sylv1(349,119) Meli alti1(107,26) Meli offi1(172,22) Myos aqua1(84,28) Odon vern1(119,54) Oena croc1(129,25) Oeno glaz1(145,25) Oxal corn1(128,39) Papa dubi1(296,122) Papa rhoe1(326,111) Papa somn1(255,124) Pent semp1(275,125) Pers lapa1(202,107) Phra aust1(146,60) Pilo aura1(176,95) Popu alba1(145,72) Popu axtr1(117,36) Popu nIta1(175,79) Pota pect1(123,33) Pseu lute1(86,30) Raph raph1(244,70)
Rese lula1(283,93) Rese lute1(117,19) Ribe sang1(101,44) Rosa rugo1(102,54) Rume hydr1(172,72) Sagi apet1(209,94) Sali alba1(208,107) Scho lacu1(84,14) Scut gale1(140,74) Sedu rupe1(111,55) Sene squa1(250,80) Sile lati1(317,106)
Sile vulg1(127,37) Sile xham1(118,33) Sisy orie1(128,21) Sola nigr1(209,102) Soli cana1(111,39) Sorb inte1(127,52) Spar emer1(98,31) Sper arve1(150,80) Symp offi1(102,51) Tana vulg1(228,77) Trif arve1(109,10) Trif camp1(209,70)
Trit aest1(177,76) Urti uren1(202,91)**98 taxa**

POSITIVE PREFERENTIALS
Vero mont1(98,224) Vero offi1(23,121) Achi ptar1(54,143) Ajug ept1(118,274) Anem nemo1(106,241) Athy fili1(<u>135,325</u>)Blec spic1(17,156) Briz medi1(23,126) Camp rotu1(<u>93,246</u>) Care cary1(12,91) Care flac1(80,184) Care pani1(57,208)
Care sylv1(54,133) Cera clav1(35,129) Chry oppo1(<u>71,258)</u> Clay sibi1(28,129) Cruc laev1(51,151) Dact fuch1(61,148)Dant decu1(13,94) Dryo affi1(44,129) Equi palu1(87,192) Equi sylv1(36,139) Euph spec1(22,90) Gali saxa1(120,266)
Geum riva1(24,88) Glyc nota1(96,215) Junc squa1(22,119) Lami gSSm1(51,150) Lari xmar1(52,130) Lath lini1(11,119)Luzu mult1(53,158) Luzu sylv1(5,117) Lych flos1(100,220) Lysi nemo1(50,213) Moli caer1(32,136) Myrr odor1(16,140)
Nard stri1(46,153) Oxal acet1(<u>82,327</u>) Pers bist1(55,152) Pimp majo1(24,126) Pimp saxi1(41,97) Pold vule1(51,113)Pote erec1(131,323) Pote ster1(<u>100,245</u>) Ranu flam1(78,236) Rosa caes1(11,115) Sali pent1(28,87) Sene aqua1(71,162)
Stac offi1(56,149) Stel alsi1(<u>123,336</u>) Succ prat1(56,238) Ulex gall1(86,209) Vacc myrt1(32,183) Vale offi1(<u>112,306</u>) **54 taxa**

NON-PREFERENTIALS

Vero agre1(206,131) Vero arve1(345,292) Vero becc1(256,377)
Vero cham1(350,412) Vero fili1(127,95) Vero hede1(300,235) Vero pers1(363,278) Vero serp1(256,325) Vibu opul1(258,309) Vici crac1(349,387) Vici hirs1(346,206) Vici sepi1(316,398) Vici snig1(154,116) Vici sseg1(281,173) Viol arve1(306,172) Viol odor1(90,63) Viol rivi1(227,342) Acer camp1(362,321) Acer plat1(234,137) Acer pseu1(387,418) Achi mill1(389,418) Adox mosc1(95,196) Aego poda1(355,371) Aesc hipp1(332,311) Agro cani1(74,136) Agro capi1(376,410) Agro giga1(206,188) Agro stol1(368,397) Alch moll1(93,79) Alis plan1(206,163) Alli peti1(383,398) Alli ursi1(125,180) Alnu glut1(368,403) Alop geni1(255,348) Alop prat1(363,408) Ange sylv1(259,375) Anis ster1(380,326) Anth odor1(316,401) Anth sylv1(389,419) Apiu nodi1(278,219) Arab thal1(331,253) Arct minu1(368,358) Aren serp1(103,86) Arrh elat1(387,416) Arte vulg1(386,346) Arum macu1(250,257) Aspl ruta1(129,76) Atri patu1(358,357) Atri pros1(316,285) Aven fatu1(182,129) Barb vulg1(192,107) Bell pere1(387,420) Betu pend1(369,369) Betu pube1(201,304) Brac

sylv1(178,189) Bras napu1(231,172) Bras rapa1(110,61) Brom hord1(369,358) Brom ramo1(163,198) Call spec1(231,299) Call vulg1(84,173) Calt palu1(156,274) Caly sepi1(354,335) Caly silv1(362,225) Caps burs1(390,409) Card amar1(92,194) Card flex1(336,403) Card hirs1(343,345) Card prat1(281,375) Care amis1(161,151) Care hirt1(265,243) Care nigr1(95,205) Care oval1(94,192) Care pata1(49,92) Care pend1(112,102) Care remo1(146,204) Carp betu1(158,105) Cast sati1(202,231) Cent eryt1(163,94) Cent nigr1(361,407) Cera font1(388,420) Cera glom1(327,382) Cera tome1(98,67) Chae temu1(176,155) Cham angu1(386,417) Chel maju1(240,163) Chen albu1(376,333) Chen rubr1(122,110) Circ lute1(162,260) Cirs arve1(390,423) Cirs palu1(217,379) Cirs vulg1(390,421) Cono maju1(254,370) Corn sang1(221,149) Cory avel1(372,409) Crat mono1(390,422) Crep capi1(367,261) Croc pott1(104,102) Cymb mura1(112,86) Cyno cris1(323,388) Cyti scop1(300,232) Dact glom1(390,422) Desc cesp1(333,396) Desc flex1(160,268) Digi purp1(382,405) Dryo dila1(324,407) Dryo fili1(382,416) Eleo palu1(124,106) Elym cani1(128,139) Elyt repe1(378,398) Epil cili1(345,353) Epil hirs1(387,415) Epil obsc1(268,304) Epil palu1(86,174) Epil parv1(262,214) Epil rose1(94,71) Epil xert1(351,384) Equi arve1(387,410) Equi fluv1(82,169) Erop vern1(120,70) Euph heli1(321,181) Euph pepl1(349,228) Fagu sylv1(325,371) Fall conv1(265,145) Fall japo1(260,182) Fest arun1(199,203) Fest giga1(142,269) Fest ovin1(143,238) Fest prat1(92,172) Fest rubr1(373,410) Fili ulma1(293,395) Frag vesc1(86,140) Frax exce1(390,420) Gala niva1(109,90) Gale tagg1(323,358) Gali apar1(390,420) Gali odor1(49,106) Gali palu1(203,347) Gali veru1(221,141) Gera diss1(361,277) Gera luci1(215,192) Gera moll1(355,211) Gera prat1(87,106) Gera robe1(379,417) Geum urba1(345,364) Glec hede1(293,339) Glyc decl1(76,157) Glyc flui1(210,341) Glyc maxi1(220,125) Gnap ulig1(211,213) Hede heli1(384,398) Hede hibe1(107,75) Hera spho1(389,420) Hesp matr1(77,97) Hier saba1(67,124) Hier vagu1(54,85) Holc lana1(387,421) Holc moll1(342,407) Humu lupu1(156,97) Hyac non-1(328,392) Hyac xmas1(189,127) Hype tetr1(111,185) Hypo radi1(384,408) Ilex aqui1(383,410) Impa glan1(236,203) Iris pseu1(316,274) Junc acut1(113,243) Junc arti1(221,310) Junc bagg1(282,346) Junc cong1(191,281) Junc effu1(378,413) Junc infl1(333,298) Knau arve1(95,92) Lami albu1(381,364) Lami gSSa1(119,134) Lami purp1(366,317) Laps comm1(385,406) Lari deci1(148,255) Lath prat1(358,404) Lemn mino1(283,272) Lemn minu1(92,59) Leon autu1(370,397) Leon hisp1(62,117) Leuc vulg1(325,305) Ligu oval1(203,116) Ligu vulg1(199,139) Linu cath1(44,91) Loli mult1(175,194) Loli pere1(387,421) Loni peri1(334,386) Lotu corn1(359,394) Lotu pedu1(221,346) Luna annu1(211,169) Luzu camp1(271,369) Lyco euro1(257,158) Lysi numm1(119,113) Lysi punc1(154,140) Maho aqui1(91,51) Malu pumi1(272,265) Matr disc1(389,414) Matr recu1(337,289) Meco camb1(117,126) Medi lupu1(373,306) Meli unif1(54,92) Ment aqua1(233,234) Ment spic1(88,83) Merc pere1(245,345) Mili effu1(80,121) Moeh trin1(144,231) Myce mura1(68,97) Myos arve1(335,344) Myos laxa1(118,229) Myos scor1(204,202) Myos sylv1(286,319) Nuph lute1(102,66) Pers amph1(253,195) Pers hydr1(160,216) Pers macu1(387,377) Peta hybr1(123,183) Phal arun1(312,338) Phle bert1(115,106) Phle prat1(360,407) Phyl scol1(158,161) Pice abie1(78,127) Pilo offi1(228,292) Pinu sylv1(279,310) Plan lanc1(390,419) Plan majo1(390,422) Poa annu1(389,419) Poa nemo1(84,101) Poa prat1(353,370) Poa triv1(378,416) Poly aren1(238,246) Poly avic1(382,405) Popu trem1(191,146) Popu xcan1(241,139) Pota nata1(100,151) Pote anse1(259,286) Pote rept1(359,321) Prim veri1(98,103) Prim vulg1(127,204) Prun aviu1(307,289) Prun dome1(243,285) Prun laur1(146,111) Prun padu1(75,132) Prun spin1(370,398) Prun vulg1(357,385) Pter aqui1(352,375) Quer cerr1(79,99) Quer petr1(98,196) Quer robu1(385,408) Quer xros1(74,114) Ranu acri1(369,414) Ranu bulb1(257,256) Ranu fica1(320,371) Ranu fSSb1(130,183) Ranu repe1(390,423) Ranu scel1(254,179) Rhin mino1(61,110) Rhod pont1(157,239) Ribe rubr1(128,178) Ribe uva-1(167,282) Rori nagg1(202,207) Rori palu1(137,96) Rosa arve1(268,369) Rosa cagg1(381,406) Rubu frut1(389,423) Rubu idae1(294,358) Rume acet1(374,408) Rume alla1(311,334) Rume cong1(250,192) Rume cris1(363,385) Rume obtu1(389,422) Rume sang1(255,311) Sagi proc1(347,335) Sali capr1(363,392) Sali cine1(347,391) Sali frag1(361,346) Sali vimi1(224,179) Sali xsmi1(87,80) Samb nigr1(390,422) Sang offi1(104,166) Scro auri1(193,119) Scro nodo1(257,317) Sedu acre1(164,102) Sedu albu1(105,64) Sene jaco1(388,409) Sene visc1(134,89) Sene vulg1(388,399) Sile dioi1(354,405) Sina arve1(269,152) Sisy offi1(388,305) Sola dulc1(377,339) Sonc arve1(332,293) Sonc aspe1(388,411) Sonc oler1(388,384) Sorb aria1(116,75) Sorb aucu1(339,375) Spar erec1(240,220) Spir spec1(87,92) Stac palu1(128,107) Stac sylv1(377,412) Stel gram1(287,355) Stel holo1(266,391) Stel medi1(390,420) Symp albu1(296,289) Symp xupl1(287,240) Syri vulg1(165,125) Tamu comm1(192,211) Tana part1(287,216) Tara offi1(389,420) Taxu bacc1(247,220) Teuc scor1(158,214) Tili xeur1(311,272) Tori japo1(210,230) Trag prat1(313,174) Trif dubi1(377,355) Trif hybr1(191,111) Trif medi1(172,212) Trif prat1(381,413) Trif repe1(389,419) Trip inod1(374,339) Tris flav1(151,220) Tuss farf1(350,372) Typh lati1(294,274) Ulex euro1(325,341) Ulmu glab1(322,372) Ulmu proc1(216,122) Urti dioi1(390,423) **329 taxa**

End of level 1

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DIVISION 2 (N= 390) I.E. GROUP *0
Eigenvalue 0.065 at iteration 3
INDICATORS,together with their SIGN
Sisy orie1(-) Vulp myur1(-) Lupi xreg1(-) Foen vulg1(-) Dauc caro1(-) Sile vulg1(-) Budd davi1(-)

Maximum indicator score for negative group -5 Minimum indicator score for positive group -4

Items in NEGATIVE group 4 (N= 79) i.e.

group *00

SJ80V SJ84N SJ84P SJ84S SJ84T SJ84U SJ84W SJ84X SJ84Y SJ85K SJ90A SJ90F
SJ90K SJ90V SJ92B SJ94B SK00A SK00B SK00C SK00G SK00I SK00J SK00K SK00L
SK00M SK00N SK01B SK10J SO88S SO88U SO88X SO88Y SO88Z SO89R SO89V SO89Y
SO98D SO98E SO98I SO98J SO98N SO98P SO98U SO99D SO99E SO99H SO99I SO99J
SO99K SO99L SO99M SO99N SO99P SO99Q SO99R SO99S SO99T SO99U SO99V SO99W
SO99X SO99Y SO99Z SP08E SP08J SP09A SP09B SP09C SP09D SP09E SP09F SP09G
SP09K SP09L SP09Q SP09R SP09S SP09T SP09X

BORDERLINE negatives (N= 8)
SJ84P SJ90A SJ92B SK00G SK00K SK10J SO99K SO99U

MISCLASSIFIED negatives (N= 4)
SJ90K SK00C SO89V SP09X

Items in POSITIVE group 5 (N= 311) i.e.

group *01

SJ71R SJ71S SJ71U SJ71V SJ71W SJ71X SJ71Z SJ72H SJ72K SJ72N SJ72R SJ72T
SJ72V SJ72W SJ75V SJ80G SJ80J SJ80K SJ80L SJ80M SJ80Q SJ80R SJ80S SJ80U
SJ80W SJ80X SJ80Y SJ80Z SJ81B SJ81F SJ81N SJ81R SJ81S SJ81W SJ81X SJ81Z
SJ82C SJ82F SJ82G SJ82P SJ82Q SJ82R SJ82S SJ82T SJ82V SJ82W SJ82X SJ82Y
SJ83F SJ83L SJ83T SJ83X SJ84D SJ84I SJ84J SJ84Q SJ85F SJ85L SJ85M SJ85Q
SJ85V SJ90B SJ90C SJ90D SJ90E SJ90G SJ90H SJ90I SJ90J SJ90L SJ90M SJ90N
SJ90P SJ90Q SJ90R SJ90S SJ90T SJ90U SJ90W SJ90X SJ90Y SJ90Z SJ91A SJ91B
SJ91C SJ91D SJ91E SJ91F SJ91G SJ91H SJ91I SJ91J SJ91L SJ91P SJ91Q SJ91R
SJ91V SJ91W SJ92A SJ92C SJ92D SJ92F SJ92G SJ92H SJ92I SJ92K SJ92L SJ92N
SJ92Q SJ92R SJ92T SJ92X SJ92Y SJ93A SJ93B SJ94C SJ94G SJ94K SK00D SK00E
SK00F SK00H SK00P SK00Q SK00R SK00S SK00T SK00U SK00V SK00W SK00X SK00Y
SK01A SK01F SK01G SK01H SK01J SK01M SK01N SK01P SK01T SK01U SK01V SK01Y
SK01Z SK02A SK02B SK02D SK02F SK02K SK02Q SK02R SK02W SK02X SK03W SK03X
SK10A SK10B SK10C SK10D SK10E SK10F SK10G SK10H SK10I SK10K SK10L SK10M
SK10N SK10P SK10Q SK10R SK10S SK10T SK10U SK10V SK10W SK10X SK10Y SK10Z
SK11A SK11B SK11C SK11D SK11F SK11G SK11H SK11I SK11J SK11K SK11L SK11M
SK11N SK11P SK11Q SK11R SK11S SK11T SK11U SK11V SK11W SK11X SK11Y SK11Z
SK12A SK12F SK12H SK12K SK12P SK12Q SK12S SK12V SK12Z SK13A SK13B SK13K
SK13Q SK20A SK20B SK20C SK20D SK20E SK20F SK20G SK20H SK20I SK20M SK20P
SK21A SK21B SK21D SK21E SK21F SK21G SK21K SK21Q SK22A SK22B SK22D SK22E
SK22F SK22G SK22H SK22I SK22J SK22K SK22L SK22M SK22N SK22R SK22S SK22T
SO78Q SO78V SO78Y SO78Z SO79Z SO88D SO88E SO88H SO88I SO88J SO88L SO88M
SO88N SO88P SO88Q SO88R SO88T SO88V SO89E SO89F SO89G SO89H SO89I SO89J
SO89K SO89L SO89M SO89N SO89P SO89Q SO89S SO89T SO89U SO89W SO89X SO89Z
SO98C SO98H SO98M SO98T SO99A SO99B SO99C SO99F SO99G SP08C SP08G SP08H
SP08I SP08P SP09H SP09I SP09J SP09M SP09N SP09P SP09U SP19Z SP29E

BORDERLINE positives (N= 19)
SJ85F SJ85L SJ85M SJ85Q SJ85V SJ90Q SJ90W SJ90Z SJ94C SK00H SK01F SK10E
SO98C SO98T SO99F SO99G SP08H SP09H SP09I

MISCLASSIFIED positives (N= 6)
SK00F SK20A SK20B SK22L SK22M SO89L

NEGATIVE PREFERENTIALS

Viol tric1(27,49) Viol xwit1(43,46) Vulp brom1(46,90) Vulp myur1(73,81) Aira cary1(18,27) Aira prae1(25,42) Alch moll1(33,60) Alis lanc1(38,9) Alnu cord1(34,27) Alnu inca1(51,68) Anth vuln1(27,15) Anti maju1(41,42)

Aqui vulg1(44,59) Aspl tric1(24,38) Beru erec1(27,23) Beta vulg1(21,9) Bide fron1(34,25) Bora offi1(16,22) Bras nigr1(16,7) Budd davi1(78,135) Buto umbe1(39,42) Cale offi1(33,31) Camp pers1(27,18) Camp posc1(21,14)

Camp trac1(20,20) Cata rigi1(17,20) Cent mont1(19,22) Cent rube1(40,61) Cent scab1(16,13) Cera deme1(23,18) Cera tome1(54,44) Chae minu1(18,24) Chen poly1(16,25) Clem vita1(28,33) Cony suma1(16,12) Corn alba1(21,24)

Corn seri1(25,32) Coto hori1(35,29) Coto rehd1(30,16) Coto sali1(23,2) Coto simo1(25,22) Coto xwat1(16,7) Croc pott1(41,63) Cupr macr1(17,25) Dauc caro1(66,80) Dipl mura1(22,13) Dipl tenu1(16,1) Elod nutt1(31,28)
Erig acer1(32,23) Erys ches1(16,6) Erys chri1(26,12) Esch cali1(31,16) Eupa cann1(30,45) Fall bald1(29,34) Foen vulg1(60,55) Gali parv1(16,10) Gali quad1(20,26) Gera sang1(16,13) Gera xoxo1(26,46) Heli annu1(26,24)
Hera mant1(16,20) Hesp matr1(27,50) Hier acum1(21,24) Hier saba1(25,42) Hier salt1(21,15) Hipp rham1(18,14) Hirs inca1(35,10) Hyac hisp1(21,30) Hype andr1(21,28) Knau arve1(39,56) Labu anag1(55,63) Lami ampl1(50,75)
Lami hybr1(32,45) Lami macu1(30,39) Lath lati1(29,24) Lava thur1(29,8) Lemn tris1(30,32) Lepi drab1(33,22) Lepi rude1(22,25) Leuc lacu1(16,20) Ligu oval1(72,131) Lina purp1(71,115) Lina vulg1(77,137) Linu cath1(17,27)
Linu usit1(23,31) Lobu mari1(43,35) Lupi xreg1(58,30) Lych coro1(29,17) Lyci barb1(20,20) Lyco escu1(20,23) Lysi punc1(58,96) Meco camb1(40,77) Medi sati1(35,32) Meli albu1(46,24) Meli alti1(51,56) Meli offi1(67,105)
Mssa offi1(17,21) Myce mura1(26,42) Myri spic1(23,29) Nard stri1(16,30) Nymp alba1(25,41) Nymp pelt1(17,20) Odon vern1(49,70) Oena croc1(54,75) Oeno bien1(16,15) Oeno glaz1(60,85) Past sati1(21,8) Phal cana1(27,23)
Picr echi1(25,31) Plat xhis1(25,31) Poa humi1(24,25) Popu alba1(51,94) Popu axtr1(40,77) Pota cris1(32,28) Pota pect1(57,66) Pota perf1(22,11) Pseu lute1(37,49) Pyru comm1(18,34) Rese lute1(56,61) Rhin mino1(26,35)
Rhus typh1(18,16) Ribe sang1(39,62) Robi pseu1(27,38) Rosa rugo1(41,61) Sagi sagi1(33,30) Sali baby1(29,30) Sali xhol1(20,21) Sapo offi1(33,22) Scut gale1(50,90) Sedu acre1(56,108) Sedu albu1(38,67) Sedu rupe1(50,61)
Sile vulg1(63,64) Sisy alti1(27,16) Sisy orie1(69,59) Soli cana1(54,57) Soli giga1(19,12) Sorb aria1(50,66) Sorb inte1(58,69) Spar emer1(36,62) Spir spec1(33,54) Syri vulg1(59,106) Thal minu1(16,6) Trif arve1(48,61) **144 taxa**

POSITIVE PREFERENTIALS
Vero mont1(4,94) Viol odor1(8,82) Adox mosc1(2,93) Anem nemo1(10,96) Arum macu1(25,225)9.0 Card amar1(6,86) Care remo1(13,133) Care ripa1(6,71) Chry oppo1(5,66) Cirs palu1(24,193) Elym cani1(14,114) Glec hede1(30,263)8.7
Lari deci1(16,132) Malv negl1(9,74) Merc pere1(25,220)8.8 Moeh trin1(13,131) Pers hydr1(17,143) Phle bert1(11,104) Pice abie1(6,72) Prim vulg1(14,113) Rume sang1(28,227)8.1 Stac palu1(7,121) Stel alsi1(12,111) Stel holo1(21,245)11.7 Tamu comm1(13,179)13.7 Vale offi1(4,108)27

NON-PREFERENTIALS

Verb thap1(61,124) Vero agre1(54,152) Vero arve1(68,277) Vero becc1(35,221) Vero cham1(59,291) Vero fili1(26,101) Vero hede1(59,241) Vero pers1(74,289) Vero serp1(45,211) Vibu opul1(64,194) Vici crac1(76,273) Vici hirs1(77,269) Vici sepi1(52,264) Vici snig1(31,123) Vici sseg1(77,204) Vici tetr1(34,69) Vinc majo1(20,59) Vinc mino1(17,40) Viol arve1(54,252) Viol rivi1(41,186) Acer camp1(74,288) Acer plat1(67,167) Acer pseu1(79,308) Achi mill1(79,310) Aego poda1(74,281) Aesc hipp1(66,266) Aeth cyna1(64,228) Agro cani1(11,63) Agro capi1(79,297) Agro giga1(47,159) Agro stol1(79,289) Ajug rept1(15,103) Alis plan1(51,155) Alli peti1(77,306) Alli ursi1(15,110) Alnu glut1(74,294) Alop geni1(51,204) Alop prat1(75,288) Anag arve1(61,227) Anch arve1(30,116) Ange sylv1(43,216) Anis ster1(78,302) Anth odor1(63,253) Anth sylv1(79,310) Apha arve1(23,91) Apiu nodi1(55,223) Arab thal1(75,256) Arct minu1(73,295) Aren serp1(33,70) Armo rust1(78,273) Arrh elat1(79,308) Arte absi1(73,167) Arte vulg1(79,307) Aspl ruta1(33,96) Athy fili1(29,106) Atri patu1(76,282) Atri pros1(62,254) Aven fatu1(35,147) Aven sati1(29,97) Ball nigr1(34,208) Barb vulg1(40,152) Bell pere1(79,308) Betu pend1(79,290) Betu pube1(52,149) Brac sylv1(24,154) Bras napu1(50,181) Bras rapa1(27,83) Brom hord1(78,291) Brom ramo1(19,144) Bryo dioi1(44,170) Call spec1(43,188) Call vulg1(24,60) Calt palu1(26,130) Caly sepi1(72,282) Caly silv1(79,283) Camp rotu1(12,81) Caps burs1(79,311) Card flex1(61,275) Card hirs1(72,271) Card nuta1(23,94) Card prat1(59,222) Care amis1(25,136) Care flac1(20,60) Care hirt1(56,209) Care nigr1(20,75) Care otru1(56,126) Care oval1(26,68) Care pend1(31,81) Care spic1(17,34) Carp betu1(38,120) Cast sati1(34,168) Cent eryt1(48,115) Cent nigr1(76,285) Cera font1(79,309) Cera glom1(75,252) Chae temu1(24,152) Cham angu1(79,307) Cham laws1(19,48) Chel maju1(52,188) Chen albu1(78,298) Chen rubr1(19,103) Circ lute1(19,143) Cirs arve1(79,311) Cirs vulg1(79,311) Coch dani1(45,180) Coni macu1(43,154) Cono maju1(38,216) Conv arve1(77,218) Cony cana1(72,190) Corn sang1(61,160) Coro didy1(51,132) Cory avel1(76,296) Crat mono1(79,311) Crep capi1(79,288) Crep vesi1(57,126) Cymb mura1(37,75) Cyno cris1(69,254) Cyti scop1(78,222) Dact glom1(79,311) Dact prae1(21,49) Desc cesp1(70,263) Desc flex1(44,116) Digi purp1(77,305) Dips full1(70,197) Dryo dila1(53,271) Dryo fili1(79,303) Eleo palu1(32,92) Elyt repe1(79,299) Epil cili1(79,266) Epil hirs1(79,308) Epil obsc1(63,205) Epil palu1(13,73) Epil parv1(62,200) Epil rose1(27,67) Epil tetr1(22,53) Epil xert1(78,273) Equi arve1(79,308) Equi fluv1(18,64) Equi palu1(14,73) Erod cicu1(43,123) Erop vern1(36,84) Euph heli1(74,247) Euph pepl1(76,273) Fagu sylv1(61,264) Fall conv1(62,203) Fall japo1(77,183) Fest arun1(52,147) Fest giga1(23,119) Fest ovin1(39,104) Fest prat1(17,75) Fest rubr1(78,295) Fili ulma1(38,255) Frag vesc1(20,66) Frax exce1(79,311) Fuma mura1(16,48) Fuma offi1(62,194) Gala niva1(13,96) Gale tagg1(58,265) Gali apar1(79,311) Gali moll1(20,47) Gali palu1(26,177) Gali saxa1(22,98) Gali veru1(48,173) Gera diss1(76,285) Gera luci1(57,158) Gera moll1(76,279) Gera prat1(24,63) Gera pusi1(56,164) Gera pyre1(47,104) Gera robe1(78,301) Geum urba1(63,282) Glyc decl1(20,56) Glyc flui1(35,175) Glyc maxi1(61,159) Glyc nota1(14,82) Gnap ulig1(32,179) Hede heli1(76,308) Hede hibe1(29,78) Hera spho1(79,310) Hier vagu1(16,38) Holc lana1(79,308) Holc moll1(71,271) Hord dist1(18,69) Hord muri1(78,252) Humu lupu1(22,134) Hyac non-1(61,267) Hyac xmas1(48,141) Hype perf1(74,242) Hype tetr1(17,94) Hypo radi1(79,305) Ilex aqui1(77,306) Impa cape1(27,68) Impa glan1(45,191) Iris pseu1(70,246) Junc acut1(17,96) Junc arti1(50,171) Junc bagg1(51,231) Junc cong1(44,147) Junc effu1(76,302) Junc infl1(71,262) Lact serr1(77,263) Lact viro1(24,58) Lami albu1(79,302) Lami gSSa1(23,96) Lami purp1(69,297) Laps comm1(78,307) Lath prat1(76,282) Lemn mino1(62,221) Lemn minu1(27,65) Leon autu1(79,291) Leon hisp1(16,46) Leuc vulg1(77,248) Ligu vulg1(28,171) Lobe erin1(17,34) Loli mult1(24,151) Loli pere1(79,308) Loni peri1(58,276) Lotu corn1(79,280) Lotu pedu1(39,182) Luna annu1(57,154) Luzu camp1(53,218) Lych flos1(14,86) Lyco euro1(65,192) Lysi numm1(28,91) Lyth sali1(28,68) Maho aqui1(26,65) Malu pumi1(69,203) Malv mosc1(54,142) Malv sylv1(73,276) Matr disc1(79,310) Matr recu1(66,271) Medi lupu1(78,295) Ment aqua1(50,183) Ment spic1(26,62) Mili effu1(10,70) Musc arme1(21,42) Myos aqua1(10,74) Myos arve1(58,277) Myos laxa1(18,100) Myos scor1(34,170) Myos sylv1(60,226) Nuph lute1(31,71) Oxal acet1(11,71) Oxal corn1(34,94) Oxal exil1(18,59) Papa dubi1(77,219) Papa rhoe1(73,253) Papa somn1(70,185) Pari juda1(16,32) Pent semp1(55,220) Pers amph1(64,189) Pers lapa1(36,166) Pers macu1(79,308) Peta hybr1(29,94) Phal arun1(64,248) Phle prat1(76,284) Phra aust1(25,121) Phyl scol1(49,109) Pilo aura1(41,135) Pilo offi1(55,173) Pinu sylv1(49,230) Plan coro1(18,38) Plan lanc1(79,311) Plan majo1(79,311) Poa annu1(79,310) Poa nemo1(15,69) Poa prat1(77,276) Poa triv1(77,301) Poly aren1(45,193) Poly avic1(79,303) Popu nIta1(43,132) Popu trem1(64,127) Popu xcan1(70,171) Pota nata1(33,67) Pote anse1(36,223) Pote erec1(24,107) Pote rept1(78,281) Pote ster1(12,88) Prim veri1(21,77) Prun aviu1(76,231) Prun dome1(35,208) Prun laur1(44,102) Prun padu1(20,55) Prun spin1(72,298) Prun vulg1(74,283) Pter aqui1(76,276) Puli dyse1(17,50) Quer cerr1(21,58) Quer petr1(24,74) Quer robu1(77,308) Quer xros1(16,58) Ranu acri1(79,290) Ranu bulb1(50,207) Ranu fica1(52,268) Ranu flam1(16,62) Ranu fSSb1(21,109) Ranu repe1(79,311) Ranu scel1(49,205) Raph raph1(70,174) Rese lula1(77,206) Rhod pont1(25,132) Ribe rubr1(22,106) Ribe uva-1(24,143) Rori amph1(23,46) Rori nagg1(44,158) Rori palu1(33,104) Rosa arve1(36,232) Rosa cagg1(77,304) Rubu frut1(79,310) Rubu idae1(68,226) Rume acet1(76,298) Rume alla1(69,242) Rume cong1(59,191) Rume cris1(77,286) Rume hydr1(57,115) Rume obtu1(79,310) Sagi apet1(54,155) Sagi proc1(79,268) Sali alba1(50,158) Sali capr1(79,284) Sali cine1(72,275) Sali frag1(75,286) Sali vimi1(59,165) Sali xsmi1(22,65) Samb nigr1(79,311) Sang offi1(24,80) Scho lacu1(26,58) Scro auri1(24,169) Scro nodo1(50,207) Sene jaco1(79,309) Sene squa1(77,173) Sene visc1(37,97) Sene vulg1(79,309) Sile dioi1(63,291) Sile lati1(76,241) Sile xham1(22,96) Sina arve1(56,213) Sisy offi1(79,309) Sola dulc1(78,299) Sola nigr1(43,166) Sola tube1(19,38) Sonc arve1(65,267) Sonc aspe1(79,309) Sonc oler1(79,309) Sorb aucu1(79,260) Spar erec1(58,182) Sper arve1(32,118) Stac sylv1(72,305) Stel gram1(52,235) Stel medi1(79,311) Symp albu1(70,226) Symp offi1(21,81) Symp xupl1(70,217) Tana part1(73,214) Tana vulg1(65,163) Tara offi1(79,310) Taxu bacc1(41,206) Teuc scor1(23,135) Thla arve1(21,56) Tili xeur1(64,247) Tori japo1(33,177) Trag prat1(76,237) Trif camp1(65,144) Trif dubi1(79,298) Trif hybr1(63,128) Trif medi1(57,115) Trif prat1(79,302) Trif repe1(79,310) Trip inod1(77,297) Tris flav1(44,107) Trit aest1(52,125) Tuss farf1(77,273) Typh lati1(64,230) Ulex euro1(74,251) Ulex gall1(24,62) Ulmu glab1(55,267) Ulmu proc1(30,186) Urti dioi1(79,311) Urti uren1(43,159)

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DIVISION 3 (N= 423) I.E. GROUP *1
Eigenvalue 0.085 at iteration 3
INDICATORS,together with their SIGN
Myrr odor1(+) Briz medi1(+) Sola dulc1(-) Vero pers1(-) Nard stri1(+) Euph pepl1(-)
Maximum indicator score for negative group 0 Minimum indicator score for positive group 1

Items in NEGATIVE group 6 (N= 320) i.e.
group *10
SJ63R SJ63W SJ63X SJ70V SJ71Q SJ71Y SJ72I SJ72L SJ72M SJ72P SJ72Q SJ72S
SJ72U SJ72X SJ72Y SJ72Z SJ73B SJ73C SJ73D SJ73E SJ73G SJ73H SJ73I SJ73J
SJ73K SJ73L SJ73M SJ73N SJ73P SJ73Q SJ73R SJ73S SJ73T SJ73U SJ73V SJ73W
SJ73X SJ73Y SJ73Z SJ74K SJ74L SJ74M SJ74N SJ74P SJ74Q SJ74R SJ74S SJ74T
SJ74U SJ74V SJ74W SJ74X SJ74Y SJ74Z SJ75K SJ75Q SJ75W SJ80A SJ80E SJ80F
SJ80N SJ80P SJ80T SJ81A SJ81C SJ81D SJ81E SJ81G SJ81H SJ81I SJ81J SJ81K
SJ81L SJ81M SJ81P SJ81Q SJ81T SJ81U SJ81V SJ81Y SJ82A SJ82B SJ82D SJ82E
SJ82H SJ82I SJ82J SJ82K SJ82L SJ82M SJ82N SJ82U SJ82Z SJ83A SJ83B SJ83C
SJ83D SJ83E SJ83G SJ83H SJ83I SJ83J SJ83K SJ83M SJ83N SJ83P SJ83Q SJ83R
SJ83S SJ83U SJ83V SJ83W SJ83Y SJ83Z SJ84A SJ84B SJ84C SJ84E SJ84F SJ84G
SJ84H SJ84K SJ84L SJ84M SJ84R SJ84V SJ84Z SJ85A SJ85B SJ85G SJ85H SJ85N
SJ85R SJ85S SJ85T SJ85U SJ85W SJ85X SJ85Y SJ85Z SJ91K SJ91M SJ91N SJ91S

SJ91T SJ91U SJ91X SJ92E SJ92J SJ92M SJ92P SJ92S SJ92U SJ92V SJ92W SJ92Z
SJ93C SJ93D SJ93E SJ93F SJ93G SJ93H SJ93I SJ93J SJ93K SJ93L SJ93M SJ93N
SJ93P SJ93Q SJ93R SJ93S SJ93T SJ93U SJ93V SJ93W SJ93X SJ93Y SJ93Z SJ94A
SJ94D SJ94E SJ94F SJ94H SJ94I SJ94J SJ94L SJ94M SJ94N SJ94P SJ94Q SJ94T
SJ94V SJ94W SJ94X SJ94Z SJ95A SJ95B SJ95E SJ95F SJ95G SJ95M SJ95N SJ95P
SJ95Q SJ95T SJ95U SJ95X SJ95Y SJ96C SJ96F SJ96G SJ96L SK00Z SK01C SK01D
SK01I SK01K SK01L SK01Q SK01R SK01S SK01W SK01X SK02C SK02E SK02G SK02H
SK02I SK02J SK02L SK02M SK02N SK02P SK02S SK02T SK02U SK02V SK02Y SK02Z
SK03A SK03B SK03C SK03D SK03E SK03F SK03G SK03H SK03I SK03J SK03K SK03L
SK03M SK03N SK03P SK03Q SK03R SK03S SK03T SK03U SK03V SK03Y SK03Z SK04A
SK04B SK04C SK04D SK04F SK04G SK04H SK04J SK04K SK04L SK04M SK04Q SK04R
SK04V SK11E SK12B SK12C SK12D SK12E SK12G SK12I SK12J SK12L SK12M SK12N
SK12R SK12T SK12U SK12W SK12X SK12Y SK13C SK13E SK13F SK14A SK14B SK14G
SK14M SK14N SK14P SK15F SK20J SK20N SK20U SK21C SK22C SO77P SO77U SO78K
SO78W SO88B SO88C SO88G SO89A SP09Z SP19P SP19U

BORDERLINE negatives (N= 25)
SJ73H SJ73K SJ81P SJ85N SJ93S SJ93T SJ94I SJ94J SJ94M SJ94N SJ94P SJ94T
SJ94Z SJ95E SJ95F SJ95N SJ95U SJ95X SJ96C SJ96F SJ96L SK01D SK04J SK04L
SK15F

MISCLASSIFIED negatives (N= 4)
SJ95M SK04H SK04M SK14P

Items in POSITIVE group 7 (N= 103) i.e.
group *11
SJ86V SJ91Y SJ91Z SJ94R SJ94S SJ94U SJ94Y SJ95C SJ95D SJ95H SJ95I SJ95J
SJ95K SJ95L SJ95R SJ95S SJ95V SJ95W SJ95Z SJ96A SJ96B SJ96K SJ96Q SJ96R
SJ96S SJ96V SJ96W SJ96X SK01E SK04E SK04I SK04N SK04P SK04S SK04T SK04U
SK04W SK04X SK04Y SK04Z SK05A SK05B SK05C SK05D SK05E SK05F SK05G SK05H
SK05I SK05J SK05K SK05L SK05M SK05N SK05P SK05Q SK05R SK05S SK05T SK05U
SK05V SK05W SK05X SK05Y SK05Z SK06A SK06B SK06C SK06D SK06F SK06G SK06H
SK06I SK06J SK06K SK06L SK06M SK06N SK06Q SK06R SK06S SK06T SK06V SK06W
SK06X SK14C SK14D SK14E SK14H SK14I SK14J SK15A SK15B SK15C SK15D SK15E
SK15G SK15H SK15I SK15J SK15K SK16A SK16B

BORDERLINE positives (N= 7)
SJ94U SJ95H SJ95L SJ95R SJ95S SK01E SK04W

MISCLASSIFIED positives (N= 11)
SJ86V SJ91Z SJ94S SJ95D SJ95I SK04I SK05E SK05T SK14C SK15D SK15K

NEGATIVE PREFERENTIALS
Vero agre1(120,11) Vero hede1(203,32) Vero pers1(256,22) Vici snig1(107,9) Vici sseg1(154,19) Viol arve1(163,9) Aeth cyna1(115,2) Alis plan1(153,10) Anag arve1(126,6) Apiu nodi1(204,15) Armo rust1(107,9) Arum macu1(225,32)
Aven fatu1(118,11) Ball nigr1(75,1) Bras napu1(153,19) Budd davi1(70,11) Caly silv1(200,25) Care pend1(91,11) Carp betu1(91,14) Cast sati1(204,27) Cent eryt1(82,12) Chae temu1(142,13) Chel maju1(147,16) Chen rubr1(98,12)
Coch dani1(86,12) Coni macu1(66,2) Conv arve1(94,11) Euph heli1(172,9) Euph pepl1(218,10) Fall conv1(136,9) Fuma offi1(75,1) Gera diss1(249,28) Gera moll1(183,28) Gnap ulig1(184,29) Hede hibe1(66,9) Hord muri1(69,5)
Humu lupu1(93,4) Hype perf1(134,20) Lact serr1(73,8) Ligu oval1(100,16) Ligu vulg1(132,7) Lyco euro1(149,9) Malv sylv1(113,6) Matr recu1(257,32) Mili effu1(108,13) Moeh trin1(199,32) Papa dubi1(109,13) Papa rhoe1(103,8)
Papa somn1(110,14) Pent semp1(112,13) Pers amph1(177,18) Pers lapa1(101,6) Pilo aura1(85,10) Popu nIta1(76,3) Popu xcan1(125,14) Prun laur1(99,12) Quer cerr1(92,7) Ranu scel1(174,5) Rese lula1(85,8) Rori palu1(88,8)
Rume hydr1(67,5) Sagi apet1(81,13) Sali alba1(97,10) Scro auri1(104,15) Scut gale1(67,7) Sile lati1(96,10) Sina arve1(144,8) Sisy offi1(265,40) Sola dulc1(304,35) Sola nigr1(102,0) Syri vulg1(110,15) Tamu comm1(199,12)
Tana vulg1(72,5) Taxu bacc1(190,30) Trif hybr1(98,13) Ulmu proc1(113,9) Urti uren1(90,1)

POSITIVE PREFERENTIALS
Vero offi1(52,69) Viol palu1(24,48) Achi ptar1(73,70) Agro vine1(14,26) Alch fili1(44,37) Alch glab1(10,58) Alch xant1(10,55) Apha arve1(33,22) Aren serp1(50,36) Aspl tric1(25,21) Blec spic1(79,77) Briz medi1(46,80)

Call vulg1(95,78) Camp lati1(29,24) Camp rotu1(147,99) Card nuta1(33,24) Care bine1(21,28) Care cary1(33,58) Care echi1(15,34) Care flac1(102,82) Care pilu1(38,28) Care vSSo1(27,41) Cent mont1(33,23) Cera tome1(37,30)
Crep palu1(8,27) Dact fuch1(74,74) Dant decu1(37,57) Empe nigr1(5,25) Epil palu1(104,70) Equi sylv1(70,69) Eric tetr1(25,30) Erio angu1(15,34) Erio arevagi1(7,26) Erop vern1(36,34) Euph spec1(27,63) Fest ovin1(139,99)
Gera prat1(50,56) Geum riva1(31,57) Heli pube1(5,22) Hier acum1(51,33) Hype pulc1(36,45) Junc bulb1(35,42) Junc squa1(59,60) Koel macr1(2,24) Lath lini1(52,67) Leon hisp1(55,62) Linu cath1(40,51) Luzu mult1(91,67)
Luzu sylv1(57,60) Moli caer1(71,65) Mont font1(30,53) Myos secu1(19,42) Myrr odor1(52,88) Nard stri1(72,81) Oreo limb1(21,57) Pedi sylv1(13,37) Pers bist1(92,60) Peta hybr1(109,74) Pimp majo1(74,52) Plan medi1(18,25)
Polg vuls1(12,25) Poly serp1(21,48) Pucc dist1(34,41) Ranu hede1(39,39) Ranu omio1(4,33) Rhin mino1(45,65) Rosa caes1(49,66) Rosa moll1(1,22) Rosa xdum(caesia x canina)(9,35) Rume alpi1(2,23) Sali auri1(33,46) Sali pent1(43,44) Sali xmul1(14,38) Sang mmin1(6,24) Saxi gran1(9,33) Sedu acre1(58,44) Sene aqua1(95,67) Thym poly1(5,26) Trig palu1(18,25) Ulex gall1(119,90) Vacc myrt1(100,83) Vacc viti1(17,38) Vale dioi1(21,44)83 taxa

NON-PREFERENTIALS
Vero arve1(242,50) Vero becc1(284,93) Vero cham1(309,103) Vero fili1(80,15) Vero mont1(177,47) Vero serp1(241,84) Vibu opul1(244,65) Vici crac1(295,92) Vici hirs1(177,29) Vici sepi1(296,102) Viol rivi1(248,94) Acer camp1(272,49)
Acer plat1(114,23) Acer pseu1(316,102) Achi mill1(316,102) Adox mosc1(156,40) Aego poda1(287,84) Aesc hipp1(240,71) Agro cani1(87,49) Agro capi1(308,102) Agro giga1(148,40) Agro stol1(297,100) Ajug rept1(191,83) Alch moll1(57,22)
Alli peti1(313,85) Alli ursi1(144,36) Alnu glut1(307,96) Alop geni1(257,91) Alop prat1(308,100) Anem nemo1(173,68) Ange sylv1(279,96) Anis ster1(278,48) Anth odor1(298,103) Anth sylv1(318,101) Arab thal1(208,45) Arct minu1(290,68)
Arrh elat1(315,101) Arte vulg1(285,61) Aspl ruta1(54,22) Athy fili1(229,96) Atri patu1(278,79) Atri pros1(222,63) Barb vulg1(91,16) Bell pere1(317,103) Betu pend1(288,81) Betu pube1(218,86) Brac sylv1(159,30) Brom hord1(273,85)
Brom ramo1(166,32) Call spec1(225,74) Calt palu1(188,86) Caly sepi1(278,57) Caps burs1(308,101) Card amar1(137,57) Card flex1(303,100) Card hirs1(265,80) Card prat1(274,101) Care amis1(125,26) Care hirt1(203,40) Care nigr1(128,77)
Care oval1(119,73) Care pani1(133,75) Care pata1(71,21) Care remo1(172,32) Care sylv1(105,28) Cent nigr1(307,100) Cera clav1(98,31) Cera font1(317,103) Cera glom1(282,100) Cham angu1(314,103) Chen albu1(285,48) Chry oppo1(173,85)
Circ lute1(215,45) Cirs arve1(320,103) Cirs palu1(276,103) Cirs vulg1(318,103) Clay sibi1(88,41) Cono maju1(275,95) Corn sang1(121,28) Cory avel1(313,96) Crat mono1(319,103) Crep capi1(220,41) Croc pott1(81,21) Cruc laev1(99,52)
Cymb mura1(59,27) Cyno cris1(285,103) Cyti scop1(195,37) Dact glom1(319,103) Desc cesp1(293,103) Desc flex1(180,88) Digi purp1(311,94) Dips full1(115,20) Dryo affi1(96,33) Dryo dila1(305,102) Dryo fili1(315,101) Eleo palu1(91,15)
Elym cani1(110,29) Elyt repe1(299,99) Epil cili1(270,83) Epil hirs1(315,100) Epil obsc1(224,80) Epil parv1(176,38) Epil xert1(287,97) Equi arve1(312,98) Equi fluv1(106,63) Equi palu1(136,56) Fagu sylv1(280,91) Fall japo1(144,38)
Fest arun1(161,42) Fest giga1(206,63) Fest prat1(108,64) Fest rubr1(307,103) Fili ulma1(296,99) Frag vesc1(100,40) Frax exce1(318,102) Gala niva1(72,18) Gale tagg1(282,76) Gali apar1(319,101) Gali odor1(76,30) Gali palu1(256,91)
Gali saxa1(171,95) Gali veru1(95,46) Gera luci1(134,58) Gera robe1(316,101) Geum urba1(292,72) Glec hede1(276,63) Glyc decl1(112,45) Glyc flui1(249,92) Glyc maxi1(105,20) Glyc nota1(168,47) Hede heli1(315,83) Hera spho1(318,102)
Hesp matr1(64,33) Hier saba1(94,30) Hier vagu1(55,30) Holc lana1(318,103) Holc moll1(307,100) Hyac non-1(298,94) Hyac xmas1(108,19) Hype tetr1(145,40) Hypo radi1(305,103) Ilex aqui1(316,94) Impa glan1(164,39) Iris pseu1(215,59)
Junc acut1(162,81) Junc arti1(221,89) Junc bagg1(260,86) Junc cong1(196,85) Junc effu1(314,99) Junc infl1(245,53) Knau arve1(57,35) Lami albu1(295,69) Lami gSSa1(112,22) Lami gSSm1(124,26) Lami macu1(52,23) Lami purp1(267,50)
Laps comm1(312,94) Lari deci1(188,67) Lari xmar1(103,27) Lath prat1(302,102) Lemn mino1(226,46) Leon autu1(296,101) Leuc vulg1(214,91) Loli mult1(161,33) Loli pere1(318,103) Loni peri1(307,79) Lotu corn1(292,102) Lotu pedu1(252,94)
Luna annu1(135,34) Luzu camp1(269,100) Luzu pilo1(44,27) Lych flos1(141,79) Lysi nemo1(139,74) Lysi numm1(91,22) Lysi punc1(98,42) Malu pumi1(216,49) Malv mosc1(68,11) Matr disc1(311,103) Meco camb1(88,38) Medi lupu1(240,66)

Meli unif1(76,16) Ment aqua1(174,60) Ment spic1(54,29) Merc pere1(277,68) Myce mura1(63,34) Myos arve1(274,70) Myos laxa1(168,61) Myos scor1(151,51) Myos sylv1(235,84) Oxal acet1(230,97) Pers hydr1(181,35) Pers macu1(301,76)
Phal arun1(257,81) Phle bert1(69,37) Phle prat1(307,100) Phyl scol1(126,35) Pice abie1(103,24) Pilo offi1(194,98) Pimp saxi1(60,37) Pinu sylv1(228,82) Plan lanc1(317,102) Plan majo1(319,103) Poa annu1(316,103) Poa nemo1(84,17)
Poa prat1(274,96) Poa triv1(314,102) Pold vule1(73,40) Poly aren1(195,51) Poly avic1(306,99) Popu trem1(111,35) Pota nata1(121,30) Pote anse1(227,59) Pote erec1(224,99) Pote rept1(271,50) Pote ster1(179,66) Prim veri1(72,31)
Prim vulg1(154,50) Prun aviu1(245,44) Prun dome1(245,40) Prun padu1(92,40) Prun spin1(309,89) Prun vulg1(283,102) Pter aqui1(293,82) Quer petr1(150,46) Quer robu1(319,89) Quer xros1(82,32) Ranu acri1(311,103) Ranu bulb1(196,60)
Ranu fica1(279,92) Ranu flam1(149,87) Ranu fSSb1(148,35) Ranu repe1(320,103) Rhod pont1(197,42) Ribe rubr1(140,38) Ribe uva-1(213,69) Rori nagg1(159,48) Rosa arve1(286,83) Rosa cagg1(311,95) Rubu frut1(320,103) Rubu idae1(262,96)
Rume acet1(305,103) Rume alla1(246,88) Rume cong1(165,27) Rume cris1(290,95) Rume obtu1(319,103) Rume sang1(262,49) Sagi proc1(251,84) Sali capr1(299,93) Sali cine1(297,94) Sali frag1(291,55) Sali vimi1(133,46) Sali xrei1(60,24)
Samb nigr1(320,102) Sang offi1(108,58) Scro nodo1(250,67) Sene jaco1(307,102) Sene squa1(67,13) Sene visc1(76,13) Sene vulg1(309,90) Sile dioi1(309,96) Sonc arve1(223,70) Sonc aspe1(311,100) Sonc oler1(299,85) Sorb aucu1(275,100)
Spar erec1(187,33) Sper arve1(67,13) Spir spec1(68,24) Stac offi1(104,45) Stac palu1(85,22) Stac sylv1(314,98) Stel alsi1(240,96) Stel gram1(259,96) Stel holo1(300,91) Stel medi1(318,102) Succ prat1(148,90) Symp albu1(224,65)
Symp xupl1(180,60) Tana part1(171,45) Tara offi1(317,103) Teuc scor1(155,59) Tili xeur1(219,53) Tori japo1(174,56) Trag prat1(136,38) Trif dubi1(277,78) Trif medi1(147,65) Trif prat1(311,102) Trif repe1(317,102) Trip inod1(282,57)
Tris flav1(147,73) Tuss farf1(275,97) Typh lati1(223,51) Ulex euro1(247,94) Ulmu glab1(292,80) Urti dioi1(320,103) Vale offi1(207,99)295 taxa

End of level 2

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DIVISION 4 (N= 79) I.E. GROUP *00
Eigenvalue 0.075 at iteration 4
INDICATORS,together with their SIGN
Gali palu1(+) Cirs palu1(+) Eleo palu1(+) Dact prae1(+) Care oval1(+)
Maximum indicator score for negative group 3 Minimum indicator score for positive group 4

Items in NEGATIVE group 8 (N= 61) i.e.
group *000
SJ80V SJ84N SJ84P SJ84S SJ84T SJ84U SJ84Y SJ90A SJ90F SJ90K SJ94B SK00A
SK00B SK01B SK10J SO88S SO88U SO88X SO88Y SO88Z SO89R SO89V SO89Y SO98D
SO98N SO98P SO98U SO99D SO99E SO99H SO99I SO99J SO99K SO99L SO99M SO99N
SO99P SO99Q SO99R SO99S SO99T SO99U SO99V SO99W SO99X SO99Y SO99Z SP08E
SP08J SP09A SP09B SP09C SP09D SP09F SP09K SP09L SP09Q SP09R SP09S SP09T
SP09X

BORDERLINE negatives (N= 3)
SK00A SK00B SO99P

MISCLASSIFIED negatives (N= 2)
SO89V SP09F

Items in POSITIVE group 9 (N= 18) i.e.
group *001
SJ84W SJ84X SJ85K SJ90V SJ92B SK00C SK00G SK00I SK00J SK00K SK00L SK00M
SK00N SO98E SO98I SO98J SP09E SP09G

BORDERLINE positives (N= 1)
SJ84X

MISCLASSIFIED positives (N= 1)

SK00G

NEGATIVE PREFERENTIALS

Viol tric1(24,3) Anch arve1(27,3) Apha arve1(21,2) Aspl tric1(21,3) Beta vulg1(20,1) Bora offi1(14,2) Cale offi1(29,4) Camp pers1(24,3) Camp posc1(20,1) Camp trac1(20,0) Cony suma1(15,1) Coto sali1(21,2) Coto simo1(22,3) Cupr macr1(16,1) Dipl tenu1(15,1) Erys ches1(15,1) Erys chri1(26,0) Fall bald1(27,2) Gali parv1(15,1) Lact viro1(21,3) Lami ampl1(46,4) Lath lati1(26,3) Lava thur1(26,3) Lobe erin1(16,1) Lobu mari1(38,5) Lyci barb1(18,2) Meco camb1(35,5) Mssa offi1(16,1) Musc arme1(19,2) Myce mura1(23,3)

Oxal exil1(17,1) Pari juda1(14,2) Ranu bulb1(44,6) Rhus typh1(17,1) Soli giga1(17,2) Thal minu1(14,2) Urti uren1(38,5) **37 taxa**

POSITIVE PREFERENTIALS

Achi ptar1(8,6) Acor cala1(4,6) Agri eupa1(6,4) Agro cani1(3,8) Aira cary1(10,8) Aira prae1(15,10) Anem nemo1(5,5) Ange sylv1(26,17) Athy fili1(18,11) Bide trip1(5,9) Blec spic1(0,5) Cala epig1(3,4) Call vulg1(10,14) Calt palu1(16,10) Care amis1(13,12) Care echi1(0,5) Care flac1(10,10) Care nigr1(8,12) Care oval1(11,15) Care pani1(2,9) Care pseu1(2,8) Care remo1(7,6) Care spic1(7,10) Care vSSo1(2,9) Cera clav1(1,4) Cera deme1(14,9) Chae minu1(11,7) Cirs palu1(7,17) Cras helm1(4,5) Dact fuch1(5,9)

Dact prae1(7,14) Dact xgra1(1,5) Dryo affi1(3,7) Dryo cart1(1,4) Eleo palu1(16,16) Elod nutt1(19,12) Epil palu1(3,10) Epip hell1(5,4) Equi fluv1(5,13) Equi palu1(5,9) Equi sylv1(4,5) Eric tetr1(1,5) Erio angu1(0,5) Eupa cann1(18,12) Euph spec1(1,7) Fest ovin1(24,15) Fest prat1(10,7) Fili ulma1(23,15) Fran alnu1(7,8) Gali palu1(9,17) Gali saxa1(10,12) Gera prat1(14,10) Glyc decl1(12,8) Glyc flui1(19,16) Glyc nota1(4,10) Hier acum1(11,10) Hier vagu1(4,12) Hier vulg1(5,7) Hipp vulg1(5,7) Hydr vulg1(0,6)

Hype tetr1(6,11) Impa cape1(15,12) Isol seta1(2,7) Junc acut1(5,12) Junc bulb1(1,6) Junc squa1(2,4) Junc tenu1(3,9) Laga majo1(6,4) Lava olbi1(2,4) Lemn minu1(16,11) Leon hisp1(10,6) Leon saxa1(4,8) Lepi lati1(6,4) Linu cath1(4,13) Lotu pedu1(24,15) Lupi poly1(0,4) Luro nata1(0,6) Luzu mult1(3,11) Lych flos1(5,9) Lysi vulg1(6,6) Moli caer1(4,7) Myos laxa1(7,11) Myos scor1(19,15) Myri spic1(11,12) Nard stri1(6,10) Nymp alba1(15,10) Onob vici1(5,4) Onon repe1(3,5) Ophi vulg1(1,5) Pers hydr1(9,8) Phra aust1(15,10) Plan medi1(2,6) Pold vule1(7,6) Pota luce1(2,7) Pota nata1(19,14) Pota perf1(12,10) Pota pusi1(2,4) Pote angl1(5,7) Pote erec1(10,14) Pote xmix1(5,7) Puli dyse1(6,11) Pyru comm1(11,7) Quer xros1(9,7) Ranu flam1(6,10) Ranu ling1(8,7) Rhin mino1(14,12) Rori amph1(11,12) Rori nagg1(26,18)

Rori palu1(19,14) Rosa rubi1(6,6) Sali xrei1(7,8) Scho lacu1(14,12) Sene aqua1(7,7) Sene eruc1(6,7) Stac palu1(3,4) Stel alsi1(4,8) Stel holo1(13,8) Succ prat1(3,5) Tamu comm1(7,6) Teuc scor1(13,10) Tili cord1(4,4) Trig palu1(1,4) Typh angu1(4,5) Ulex gall1(15,9) Vacc myrt1(2,5)**125 taxa**

NON-PREFERENTIALS

Verb thap1(46,15) Vero agre1(43,11) Vero arve1(56,12) Vero becc1(24,11) Vero cham1(46,13) Vero fili1(22,4) Vero hede1(49,10) Vero pers1(58,16) Vero serp1(37,8) Vibu opul1(50,14) Vici crac1(58,18) Vici hirs1(59,18)

Vici sepi1(40,12) Vici snig1(22,9) Vici sseg1(59,18) Vici tetr1(22,12) Vinc majo1(17,3) Vinc mino1(13,4) Viol arve1(44,10) Viol rivi1(30,11) Viol xwit1(36,7) Vulp brom1(36,10) Vulp myur1(58,15) Acer camp1(57,17)

Acer plat1(56,11) Acer pseu1(61,18) Achi mill1(61,18) Aego poda1(58,16) Aesc hipp1(51,15) Aeth cyna1(52,12) Agro capi1(61,18) Agro giga1(34,13) Agro stol1(61,18) Ajug rept1(10,5) Alch moll1(28,5) Alis lanc1(27,11)

Alis plan1(34,17) Alli peti1(60,17) Alli ursi1(13,2) Alnu cord1(27,7) Alnu glut1(56,18) Alnu inca1(39,12) Alop geni1(35,16) Alop prat1(59,16) Anag arve1(51,10) Anis ster1(61,17) Anth odor1(46,17) Anth sylv1(61,18)

Anth vuln1(19,8) Anti maju1(33,8) Apiu nodi1(38,17) Aqui vulg1(37,7) Arab thal1(60,15) Arct minu1(57,16) Aren serp1(22,11) Armo rust1(60,18) Arrh elat1(61,18) Arte absi1(57,16) Arte vulg1(61,18) Arum macu1(20,5)

Aspl adia1(10,4) Aspl ruta1(26,7) Atri patu1(60,16) Atri pros1(48,14) Aven fatu1(27,8) Aven sati1(24,5) Ball nigr1(25,9) Barb vulg1(32,8) Bell pere1(61,18) Beru erec1(19,8) Betu pend1(61,18) Betu pube1(35,17)

Bide fron1(22,12) Brac sylv1(19,5) Bras napu1(41,9) Bras nigr1(13,3) Bras rapa1(20,7) Brom hord1(61,17) Brom ramo1(14,5) Bryo dioi1(34,10) Budd davi1(61,17) Buto umbe1(27,12) Call spec1(30,13) Caly sepi1(57,15)

Caly silv1(61,18) Camp rotu1(8,4) Caps burs1(61,18) Card cris1(8,4) Card flex1(49,12) Card hirs1(56,16) Card nuta1(16,7) Card prat1(43,16) Care hirt1(38,18) Care muri1(9,5) Care otru1(39,17) Care pend1(23,8)

Carp betu1(28,10) Cast sati1(24,10) Cata rigi1(13,4) Cent eryt1(32,16) Cent mont1(16,3) Cent nigr1(58,18) Cent rube1(33,7) Cent scab1(11,5) Cera font1(61,18) Cera glom1(59,16) Cera tome1(45,9) Chae temu1(18,6)

Cham angu1(61,18) Cham laws1(15,4) Chel maju1(42,10) Chen albu1(61,17) Chen poly1(12,4) Chen rubr1(12,7) Cich inty1(9,4) Circ lute1(16,3) Cirs arve1(61,18) Cirs vulg1(61,18) Clem vita1(24,4) Coch dani1(32,13)

Coni macu1(35,8) Cono maju1(29,9) Conv arve1(60,17) Cony cana1(59,13) Corn alba1(17,4) Corn sang1(49,12) Corn seri1(17,8) Coro didy1(42,9) Cory avel1(59,17) Coto hori1(29,6) Coto rehd1(24,6) Coto xwat1(11,5)

Crat mono1(61,18) Crep capi1(61,18) Crep vesi1(46,11) Croc pott1(31,10) Cymb mura1(29,8) Cyno cris1(51,18) Cyti scop1(60,18) Dact glom1(61,18) Dauc caro1(48,18) Desc cesp1(52,18) Desc flex1(28,16) Digi purp1(59,18)

Dipl mura1(17,5) Dips full1(53,17) Dryo dila1(37,16) Dryo fili1(61,18) Elod cana1(9,5) Elyt repe1(61,18) Epil cili1(61,18) Epil hirs1(61,18) Epil obsc1(49,14) Epil parv1(45,17) Epil rose1(22,5) Epil tetr1(15,7)
Epil xert1(60,18) Equi arve1(61,18) Erig acer1(25,7) Erod cicu1(35,8) Erop vern1(27,9) Esch cali1(27,4) Euph heli1(58,16) Euph pepl1(61,15) Fagu sylv1(48,13) Fall conv1(51,11) Fall japo1(59,18) Fest arun1(36,16)
Fest giga1(18,5) Fest rubr1(60,18) Foen vulg1(46,14) Frag vesc1(14,6) Frax exce1(61,18) Fuma mura1(12,4) Fuma offi1(51,11) Gale tagg1(42,16) Gali apar1(61,18) Gali moll1(14,6) Gali quad1(16,4) Gali veru1(35,13)
Gera diss1(60,16) Gera luci1(44,13) Gera moll1(60,16) Gera pusi1(46,10) Gera pyre1(38,9) Gera robe1(61,17) Gera sang1(12,4) Gera xoxo1(22,4) Geum urba1(51,12) Glec hede1(24,6) Glyc maxi1(44,17) Gnap ulig1(25,7)
Hede heli1(60,16) Hede hibe1(23,6) Heli annu1(22,4) Hera mant1(12,4) Hera spho1(61,18) Hesp matr1(18,9) Hier saba1(17,8) Hier salt1(17,4) Hipp rham1(14,4) Hirs inca1(28,7) Holc lana1(61,18) Holc moll1(53,18)
Hord dist1(14,4) Hord muri1(60,18) Humu lupu1(17,5) Hyac hisp1(17,4) Hyac non-1(46,15) Hyac xmas1(40,8) Hype andr1(17,4) Hype perf1(56,18) Hypo radi1(61,18) Ilex aqui1(59,18) Impa glan1(35,10) Iris pseu1(52,18)
Junc arti1(33,17) Junc bagg1(37,14) Junc cong1(28,16) Junc effu1(58,18) Junc infl1(53,18) Knau arve1(28,11) Labu anag1(45,10) Lact serr1(59,18) Lami albu1(61,18) Lami gSSa1(17,6) Lami hybr1(25,7) Lami macu1(23,7)
Lami purp1(55,14) Laps comm1(61,17) Lari deci1(12,4) Lath prat1(58,18) Lemn mino1(46,16) Lemn tris1(22,8) Leon autu1(61,18) Lepi drab1(28,5) Lepi rude1(18,4) Leuc lacu1(11,5) Leuc vulg1(59,18) Ligu oval1(57,15)
Ligu vulg1(23,5) Lina purp1(57,14) Lina vulg1(59,18) Linu usit1(19,4) Loli mult1(17,7) Loli pere1(61,18) Loni peri1(42,16) Lotu corn1(61,18) Luna annu1(46,11) Lupi xreg1(44,14) Luzu camp1(40,13) Lych coro1(24,5)
Lyco escu1(17,3) Lyco euro1(48,17) Lysi numm1(20,8) Lysi punc1(42,16) Lyth sali1(18,10) Maho aqui1(21,5) Malu pumi1(52,17) Malv mosc1(43,11) Malv sylv1(57,16) Matr disc1(61,18) Matr recu1(52,14) Medi lupu1(60,18)
Medi sati1(23,12) Meli albu1(35,11) Meli alti1(34,17) Meli offi1(50,17) Ment aqua1(33,17) Ment spic1(19,7) Merc pere1(17,8) Myos arve1(45,13) Myos sylv1(49,11) Nuph lute1(21,10) Nymp pelt1(13,4) Odon vern1(32,17)
Oena croc1(40,14) Oeno bien1(13,3) Oeno glaz1(48,12) Orig vulg1(10,4) Oxal acet1(7,4) Oxal corn1(28,6) Papa dubi1(60,17) Papa rhoe1(58,15) Papa somn1(57,13) Past sati1(15,6) Pent semp1(45,10) Pers amph1(47,17)
Pers bist1(10,4) Pers lapa1(25,11) Pers macu1(61,18) Peta hybr1(23,6) Phal arun1(46,18) Phal cana1(21,6) Phle bert1(7,4) Phle prat1(58,18) Phyl scol1(40,9) Picr echi1(16,9) Pilo aura1(30,11) Pilo offi1(40,15) Pinu sylv1(36,13) Plan coro1(14,4) Plan lanc1(61,18) Plan majo1(61,18) Plat xhis1(21,4) Poa annu1(61,18) Poa humi1(18,6) Poa prat1(59,18) Poa triv1(60,17) Poly aren1(35,10) Poly avic1(61,18) Popu alba1(39,12) Popu axtr1(28,12) Popu nIta1(33,10) Popu trem1(47,17) Popu xcan1(54,16) Pota cris1(21,11) Pota pect1(40,17) Pote anse1(27,9) Pote rept1(60,18) Prim veri1(17,4) Prim vulg1(10,4) Prun aviu1(61,15) Prun dome1(25,10) Prun laur1(37,7) Prun padu1(13,7) Prun spin1(56,16) Prun vulg1(57,17) Pseu lute1(32,5) Pter aqui1(58,18) Quer cerr1(15,6) Quer petr1(18,6) Quer robu1(59,18) Quer rubr1(9,5) Ranu acri1(61,18) Ranu fica1(40,12) Ranu fSSb1(17,4) Ranu repe1(61,18) Ranu scel1(33,16) Raph raph1(56,14) Rese lula1(59,18) Rese lute1(43,13) Rhod pont1(21,4) Ribe rubr1(17,5) Ribe sang1(30,9) Ribe uva-1(18,6) Robi pseu1(21,6) Rosa arve1(23,13) Rosa cagg1(59,18) Rosa rugo1(31,10) Rubu frut1(61,18) Rubu idae1(53,15) Rume acet1(58,18) Rume alla1(51,18)
Rume cong1(41,18) Rume cris1(59,18) Rume hydr1(41,16) Rume obtu1(61,18) Rume sang1(20,8) Sagi apet1(42,12) Sagi proc1(61,18) Sagi sagi1(25,8) Sali alba1(38,12) Sali baby1(24,5) Sali capr1(61,18) Sali cine1(54,18)
Sali frag1(57,18) Sali vimi1(43,16) Sali xhol1(14,6) Sali xsmi1(15,7) Samb nigr1(61,18) Sang mmur1(11,4) Sang offi1(16,8) Sapo offi1(26,7) Scro auri1(16,8) Scro nodo1(37,13) Scut gale1(35,15) Sedu acre1(43,13) Sedu albu1(28,10) Sedu rupe1(41,9) Sene jaco1(61,18) Sene squa1(61,16) Sene visc1(27,10) Sene vulg1(61,18) Sile dioi1(47,16) Sile lati1(59,17) Sile vulg1(47,16) Sile xham1(16,6) Sina arve1(43,13) Sisy alti1(23,4) Sisy offi1(61,18) Sisy orie1(57,12) Sola dulc1(60,18) Sola nigr1(37,6) Sola tube1(15,4) Soli cana1(46,8) Sonc arve1(48,17) Sonc aspe1(61,18) Sonc oler1(61,18) Sorb aria1(40,10) Sorb aucu1(61,18) Sorb inte1(45,13)
Spar emer1(25,11) Spar erec1(40,18) Sper arve1(24,8) Spir spec1(23,10) Stac offi1(9,5) Stac sylv1(55,17) Stel gram1(36,16) Stel medi1(61,18) Symp albu1(58,12) Symp offi1(14,7) Symp xupl1(55,15) Syri vulg1(48,11)
Tana part1(58,15) Tana vulg1(50,15) Tara offi1(61,18) Taxu bacc1(31,10) Thla arve1(15,6) Tili xeur1(49,15) Tori japo1(23,10) Trag prat1(59,17) Trif arve1(39,9) Trif camp1(49,16) Trif dubi1(61,18) Trif hybr1(48,15)
Trif medi1(39,18) Trif prat1(61,18) Trif repe1(61,18) Trip inod1(60,17) Tris flav1(29,15) Trit aest1(42,10) Tuss farf1(59,18) Typh lati1(46,18) Ulex euro1(56,18) Ulmu glab1(42,13) Ulmu proc1(25,5) Urti dioi1(61,18)

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DIVISION 5 (N= 311) I.E. GROUP *01
Eigenvalue 0.040 at iteration 4
INDICATORS,together with their SIGN
Meli offi1(-) Sene squa1(-) Fall japo1(-) Budd davi1(-) Meli alti1(-) Lina vulg1(-) Care oval1(-)
Maximum indicator score for negative group -5 Minimum indicator score for positive group -4

Items in NEGATIVE group 10 (N= 71) i.e.
group *010
SJ80W SJ82F SJ82X SJ83L SJ84D SJ84I SJ84J SJ85F SJ85L SJ85M SJ85Q SJ85V
SJ90J SJ90Q SJ90S SJ90T SJ90W SJ90X SJ90Z SJ91H SJ91Q SJ91R SJ91V SJ91W
SJ92C SJ92F SJ92G SJ92H SJ94C SJ94G SJ94K SK00E SK00F SK00H SK00P SK01A
SK01F SK01G SK01N SK02A SK03W SK10E SK10S SK11A SK20A SK20B SK20C SK20F
SK20G SK20H SK22A SK22G SK22L SK22M SK22R SO89L SO89Q SO89T SO89U SO89W
SO89X SO98C SO98T SO99A SO99B SO99C SO99F SO99G SP09H SP09I SP09M

BORDERLINE negatives (N= 8)
SJ90X SJ91Q SJ91R SJ91W SK01A SK10S SK20H SK22G

MISCLASSIFIED negatives (N= 12)
SJ82F SJ83L SJ91H SK00H SK01F SK02A SK10E SK11A SO89W SO89X SP09I SP09M

Items in POSITIVE group 11 (N= 240) i.e.
group *011
SJ71R SJ71S SJ71U SJ71V SJ71W SJ71X SJ71Z SJ72H SJ72K SJ72N SJ72R SJ72T
SJ72V SJ72W SJ75V SJ80G SJ80J SJ80K SJ80L SJ80M SJ80Q SJ80R SJ80S SJ80U
SJ80X SJ80Y SJ80Z SJ81B SJ81F SJ81N SJ81R SJ81S SJ81W SJ81X SJ81Z SJ82C
SJ82G SJ82P SJ82Q SJ82R SJ82S SJ82T SJ82V SJ82W SJ82Y SJ83F SJ83T SJ83X
SJ84Q SJ90B SJ90C SJ90D SJ90E SJ90G SJ90H SJ90I SJ90L SJ90M SJ90N SJ90P
SJ90R SJ90U SJ90Y SJ91A SJ91B SJ91C SJ91D SJ91E SJ91F SJ91G SJ91I SJ91J
SJ91L SJ91P SJ92A SJ92D SJ92I SJ92K SJ92L SJ92N SJ92Q SJ92R SJ92T SJ92X
SJ92Y SJ93A SJ93B SK00D SK00Q SK00R SK00S SK00T SK00U SK00V SK00W SK00X
SK00Y SK01H SK01J SK01M SK01P SK01T SK01U SK01V SK01Y SK01Z SK02B SK02D
SK02F SK02K SK02Q SK02R SK02W SK02X SK03X SK10A SK10B SK10C SK10D SK10F
SK10G SK10H SK10I SK10K SK10L SK10M SK10N SK10P SK10Q SK10R SK10T SK10U
SK10V SK10W SK10X SK10Y SK10Z SK11B SK11C SK11D SK11F SK11G SK11H SK11I
SK11J SK11K SK11L SK11M SK11N SK11P SK11Q SK11R SK11S SK11T SK11U SK11V
SK11W SK11X SK11Y SK11Z SK12A SK12F SK12H SK12K SK12P SK12Q SK12S SK12V
SK12Z SK13A SK13B SK13K SK13Q SK20D SK20E SK20I SK20M SK20P SK21A SK21B
SK21D SK21E SK21F SK21G SK21K SK21Q SK22B SK22D SK22E SK22F SK22H SK22I
SK22J SK22K SK22N SK22S SK22T SO78Q SO78V SO78Y SO78Z SO79Z SO88D SO88E
SO88H SO88I SO88J SO88L SO88M SO88N SO88P SO88Q SO88R SO88T SO88V SO89E
SO89F SO89G SO89H SO89I SO89J SO89K SO89M SO89N SO89P SO89S SO89Z SO98H
SO98M SP08C SP08G SP08H SP08I SP08P SP09J SP09N SP09P SP09U SP19Z SP29E

BORDERLINE positives (N= 13)
SJ80R SJ80Z SJ82W SJ83X SJ84Q SJ90B SJ92K SK00D SK03X SK13K SK22N SO89Z
SP08H

MISCLASSIFIED positives (N= 6)
SJ90Y SK11C SK21E SK22F SK22K SO88V

NEGATIVE PREFERENTIALS
Vulp myur1(35,46) Achi ptar1(18,22) Alch moll1(23,37) Alnu cord1(15,12) Alnu inca1(34,34) Anti maju1(24,18) Aqui vulg1(30,29) Aspl tric1(17,21) Bide trip1(19,17) Budd davi1(57,78) Buto umbe1(17,25) Call vulg1(30,30)
Care flac1(31,29) Care nigr1(36,39) Care oval1(39,29) Care pani1(23,23) Care pend1(31,50) Cent eryt1(50,65) Cent rube1(27,34) Cera tome1(21,23) Corn seri1(17,15) Coto hori1(15,14) Coto simo1(15,7) Croc pott1(31,32)
Dact fuch1(27,20) Dact prae1(30,19) Dauc caro1(33,47) Eleo palu1(35,57) Elod cana1(21,35) Elod nutt1(17,11) Epil rose1(26,41) Epil tetr1(20,33) Equi fluv1(25,39) Fest ovin1(41,63) Foen vulg1(30,25) Gera xoxo1(20,26)
Hesp matr1(19,31) Hier saba1(22,20) Hier vulg1(15,12) Hype andr1(16,12) Junc acut1(38,58) Knau arve1(26,30) Lami macu1(16,23) Lemn tris1(15,17) Ligu oval1(51,80) Lina purp1(46,69) Lina vulg1(59,78) Linu cath1(16,11)
Lobe erin1(17,17) Lobu mari1(18,17) Lupi xreg1(15,15) Luzu mult1(17,22) Lych flos1(34,52) Lysi punc1(44,52) Lyth sali1(27,41) Meco camb1(36,41) Medi sati1(18,14) Meli albu1(20,4) Meli alti1(40,16) Meli offi1(55,50)
Ment spic1(28,34) Myce mura1(16,26) Nard stri1(19,11) Nuph lute1(28,43) Nymp alba1(16,25) Odon vern1(40,30) Oeno glaz1(42,43) Ophr apif1(21,9) Pers bist1(16,25) Picr echi1(16,15) Plat xhis1(16,15) Popu alba1(39,55)

Popu axtr1(33,44) Pseu lute1(24,25) Puli dyse1(19,31) Ranu flam1(28,34) Rese lute1(28,33) Rhin mino1(21,14) Ribe nigr1(18,23) Ribe sang1(32,30) Robi pseu1(17,21) Rosa rugo1(36,25) Scho lacu1(23,35) Sedu rupe1(34,27)

Sene squa1(67,106) Sene visc1(37,60) Sile vulg1(29,35) Sisy orie1(27,32) Soli cana1(26,31) Sorb aria1(30,36) Sorb inte1(39,30) Spir spec1(21,33) Succ prat1(23,25) Symp offi1(32,49) Trif arve1(29,32) Trif medi1(47,68)

POSITIVE PREFERENTIALS

Coro squa1 *archaeophyte,dry or winter-wet,compacted,eg around gateways*(5,51) Pice abie1(6,66)

NON-PREFERENTIALS

Verb thap1(43,81*) Vero agre1(44,108) Vero arve1(64,213) Vero becc1(50,171) Vero cham1(65,226) Vero fili1(36,65) Vero hede1(58,183) Vero mont1(22,72) Vero pers1(65,224) Vero serp1(51,160) Vibu opul1(62,132*) Vici crac1(71,202) Vici hirs1(71,198) Vici sepi1(64,200) Vici snig1(41,82) Vici sseg1(56,148) Vici tetr1(25,44) Viol arve1(49,203) Viol odor1(18,64) Viol rivi1(47,139) Viol tric1(18,31) Vulp brom1(33,57) Acer camp1(66,222*) Acer plat1(51,116) Acer pseu1(71,237) Achi mill1(71,239) Adox mosc1(13,80) Aego poda1(67,214) Aesc hipp1(64,202) Aeth cyna1(55,173) Agro cani1(16,47) Agro capi1(70,227) Agro giga1(40,119) Agro stol1(68,221) Ajug rept1(26,77) Alis plan1(52,103) Alli peti1(69,237) Alli ursi1(26,84) Alnu glut1(70,224) Alop geni1(55,149) Alop prat1(69,219) Anag arve1(47,180) Anch arve1(19,97) Anem nemo1(28,68) Ange sylv1(56,160) Anis ster1(67,235) Anth odor1(66,187) Anth sylv1(71,239) Apha arve1(17,74) Apiu nodi1(50,173) Arab thal1(64,192) Arct minu1(68,227) Aren serp1(25,45) Armo rust1(66,207) Arrh elat1(71,237) Arte absi1(53,114) Arte vulg1(71,236) Arum macu1(43,182) Aspl ruta1(30,66) Athy fili1(29,77) Atri patu1(68,214) Atri pros1(58,196) Aven fatu1(31,116) Aven sati1(23,74) Ball nigr1(33,175) Barb vulg1(38,114) Bell pere1(71,237) Betu pend1(70,220) Betu pube1(51,98) Brac sylv1(29,125) Bras napu1(45,136) Bras rapa1(28,55) Brom hord1(65,226) Brom ramo1(32,112) Bryo dioi1(31,139) Call spec1(53,135) Calt palu1(41,89) Caly sepi1(69,213) Caly silv1(70,213) Camp rotu1(20,61) Caps burs1(71,240) Card amar1(24,62) Card cris1(9,49) Card flex1(59,216) Card hirs1(68,203) Card nuta1(17,77) Card prat1(63,159) Care amis1(38,98) Care hirt1(61,148) Care otru1(44,82) Care remo1(30,103) Care ripa1(21,50) Care sylv1(15,32) Carp betu1(35,85) Cast sati1(36,132) Cent nigr1(71,214) Cera font1(71,238) Cera glom1(61,191) Chae temu1(26,126) Cham angu1(71,236) Chel maju1(47,141) Chen albu1(68,230) Chen rubr1(23,80) Chry oppo1(18,48) Circ lute1(34,109) Cirs arve1(71,240) Cirs palu1(53,140) Cirs vulg1(71,240) Coch dani1(41,139) Coni macu1(32,122) Cono maju1(56,160) Conv arve1(55,163) Cony cana1(53,137) Corn sang1(49,111) Coro didy1(40,92) Cory avel1(68,228) Crat mono1(71,240) Crep capi1(70,218) Crep vesi1(46,80) Cymb mura1(24,51) Cyno cris1(69,185) Cyti scop1(67,155) Dact glom1(71,240) Desc cesp1(70,193) Desc flex1(42,74) Digi purp1(70,235) Dips full1(60,137) Dryo dila1(69,202) Dryo fili1(71,232) Elym cani1(19,95) Elyt repe1(70,229) Epil cili1(62,204) Epil hirs1(71,237) Epil obsc1(51,154) Epil palu1(24,49) Epil parv1(60,140) Epil xert1(70,203) Equi arve1(71,237) Equi palu1(26,47) Erod cicu1(29,94) Erop vern1(27,57) Euph heli1(65,182) Euph pepl1(62,211) Fagu sylv1(56,208) Fall conv1(33,170) Fall japo1(68,115) Fest arun1(43,104) Fest giga1(32,87) Fest prat1(19,56) Fest rubr1(70,225) Fili ulma1(51,204) Frag vesc1(24,42) Frax exce1(71,240) Fuma offi1(49,145) Gala niva1(13,83) Gale tagg1(59,206) Gali apar1(71,240) Gali moll1(17,30) Gali palu1(51,126) Gali saxa1(30,68) Gali veru1(38,135) Gera diss1(69,216) Gera luci1(54,104) Gera moll1(62,217) Gera prat1(23,40) Gera pusi1(43,121) Gera pyre1(32,72) Gera robe1(70,231) Geum urba1(63,219) Glec hede1(43,220) Glyc decl1(15,41) Glyc flui1(55,120) Glyc maxi1(44,115) Glyc nota1(24,58) Gnap ulig1(32,147) Hede heli1(69,239) Hede hibe1(26,52) Hera spho1(71,239) Holc lana1(71,237) Holc moll1(66,205) Hord dist1(12,57) Hord muri1(64,188) Humu lupu1(27,107) Hyac non-1(58,209) Hyac xmas1(40,101) Hype perf1(63,179) Hype tetr1(25,69) Hypo radi1(71,234) Ilex aqui1(70,236) Impa cape1(17,51) Impa glan1(38,153) Iris pseu1(69,177) Junc arti1(63,108) Junc bagg1(54,177) Junc cong1(54,93) Junc effu1(70,232) Junc infl1(68,194) Labu anag1(23,40) Lact serr1(67,196) Lact viro1(16,42) Lami albu1(65,237) Lami ampl1(22,53) Lami gSSa1(25,71) Lami purp1(68,229) Laps comm1(70,237) Lari deci1(25,107) Lath prat1(71,211) Lemn mino1(54,167) Lemn minu1(16,49) Leon autu1(70,221) Leon hisp1(16,30) Leuc vulg1(69,179) Ligu vulg1(40,131) Loli mult1(27,124) Loli pere1(71,237) Loni peri1(60,216) Lotu corn1(71,209) Lotu pedu1(53,129) Luna annu1(46,108) Luzu camp1(63,155) Lyco euro1(50,142) Lysi numm1(30,61) Maho aqui1(18,47) Malu pumi1(55,148) Malv mosc1(43,99) Malv negl1(17,57) Malv sylv1(59,217) Matr disc1(71,239) Matr recu1(60,211) Medi lupu1(70,225) Ment aqua1(55,128) Merc pere1(41,179) Mili effu1(13,57) Moeh trin1(23,108) Myos aqua1(19,55) Myos arve1(62,215) Myos laxa1(29,71) Myos scor1(47,123) Myos sylv1(57,169) Oena croc1(25,50) Oxal acet1(15,56) Oxal corn1(34,60) Oxal exil1(18,41) Papa dubi1(58,161) Papa rhoe1(58,195) Papa somn1(56,129) Pent semp1(45,175) Pers amph1(50,139) Pers hydr1(31,112) Pers lapa1(40,126) Pers macu1(71,237) Peta hybr1(25,69) Phal arun1(61,187) Phle bert1(26,78) Phle prat1(68,216) Phra aust1(35,86) Phyl scol1(40,69) Pilo aura1(46,89) Pilo offi1(52,121) Pinu sylv1(51,179) Plan lanc1(71,240) Plan majo1(71,240 Poa annu1(71,239) Poa nemo1(19,50) Poa prat1(68,208) Poa triv1(70,231) Poly aren1(47,146) Poly avic1(71,232) Popu nIta1(37,95) Popu trem1(47,80) Popu xcan1(47,124) Pota nata1(23,44) Pota pect1(22,44) Pote anse1(50,173) Pote erec1(38,69) Pote rept1(66,215) Pote ster1(20,68) Prim veri1(25,52) Prim vulg1(22,91) Prun aviu1(62,169) Prun dome1(51,157) Prun laur1(34,68) Prun padu1(20,35) Prun spin1(67,231) Prun vulg1(70,213) Pter aqui1(66,210) Quer cerr1(16,42) Quer petr1(21,53) Quer robu1(71,237) Ranu acri1(71,219) Ranu bulb1(60,147) Ranu fica1(59,209) Ranu fSSb1(18,91) Ranu repe1(71,240) Ranu scel1(49,156) Raph raph1(50,124) Rese lula1(65,141) Rhod pont1(34,98) Ribe rubr1(

25,81) Ribe uva-1(29,114) Rori nagg1(44,114) Rori palu1(25,79) Rosa arve1(51,181) Rosa cagg1(70,234) Rubu frut1(71,239) Rubu idae1(62,164) Rume acet1(71,227) Rume alla1(66,176) Rume cong1(51,140) Rume cris1(70,216) Rume hydr1(33,82) Rume obtu1(71,239) Rume sang1(47,180) Sagi apet1(49,106) Sagi proc1(69,199) Sali alba1(51,107) Sali capr1(70,214) Sali cine1(69,206) Sali frag1(67,219) Sali vimi1(57,108) Sali xsmi1(17,48*) Samb nigr1(71,240) Sang offi1(27,53) Scro auri1(34,135) Scro nodo1(53,154) Scut gale1(32,58) Sedu acre1(39,69) Sedu albu1(24,43) Sene jaco1(71,238) Sene vulg1(70,239) Sile dioi1(64,227) Sile lati1(61,180) Sile xham1(18,78) Sina arve1(56,157) Sisy offi1(71,238) Sola dulc1(70,229) Sola nigr1(29,137) Sonc arve1(58,209) Sonc aspe1(71,238) Sonc oler1(71,238) Sorb aucu1(69,191*) Spar emer1(21,41) Spar erec1(53,129) Sper arve1(24,94) Stac offi1(15,27) Stac palu1(27,94) Stac sylv1(70,235) Stel alsi1(30,81) Stel gram1(55,180) Stel holo1(43,202) Stel medi1(71,240) Symp albu1(61,165) Symp xupl1(59,158) Syri vulg1(32,74) Tamu comm1(30,149) Tana part1(59,155) Tana vulg1(50,113) Tara offi1(71,239) Taxu bacc1(47,159*) Teuc scor1(24,111) Thla arve1(18,38) Tili xeur1(60,187* Tori japo1(39,138) Trag prat1(66,171) Trif camp1(49,95) Trif dubi1(68,230) Trif hybr1(44,84) Trif prat1(71,231) Trif repe1(71,239) Trip inod1(70,227) Tris flav1(32,75) Trit aest1(39,86) Tuss farf1(71,202) Typh lati1(67,163) Ulex euro1(66,185) Ulex gall1(19,43) Ulmu glab1(52,215) Ulmu proc1(34,152) Urti dioi1(71,240) Urti uren1(30,129) Vale offi1(29,79)
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DIVISION 6 (N= 320) I.E. GROUP *10
Eigenvalue 0.049 at iteration 3
INDICATORS,together with their SIGN
Call vulg1(+) Vacc myrt1(+) Gali saxa1(+) Arum macu1(-) Desc flex1(+) Fest ovin1(+) Nard stri1(+)
Maximum indicator score for negative group 3 Minimum indicator score for positive group 4

Items in NEGATIVE group 12 (N= 240) i.e.
group *100
SJ63R SJ63W SJ63X SJ70V SJ71Q SJ71Y SJ72I SJ72L SJ72M SJ72P SJ72Q SJ72S
SJ72U SJ72X SJ72Y SJ72Z SJ73B SJ73C SJ73D SJ73E SJ73J SJ73P SJ73Q SJ73R
SJ73S SJ73T SJ73V SJ73W SJ73X SJ73Y SJ74K SJ74L SJ74M SJ74N SJ74P SJ74Q
SJ74R SJ74S SJ74T SJ74U SJ74V SJ74W SJ74X SJ75K SJ75Q SJ75W SJ80A SJ80E
SJ80F SJ80N SJ80P SJ80T SJ81A SJ81C SJ81D SJ81E SJ81G SJ81H SJ81I SJ81J
SJ81K SJ81L SJ81M SJ81P SJ81Q SJ81T SJ81U SJ81V SJ81Y SJ82B SJ82D SJ82E
SJ82H SJ82I SJ82J SJ82K SJ82L SJ82M SJ82N SJ82U SJ82Z SJ83A SJ83B SJ83C
SJ83D SJ83E SJ83G SJ83H SJ83I SJ83J SJ83K SJ83M SJ83N SJ83P SJ83Q SJ83R
SJ83S SJ83U SJ83V SJ83W SJ83Z SJ84A SJ84B SJ84C SJ84F SJ84G SJ84H SJ84L
SJ84M SJ84R SJ85B SJ85T SJ91K SJ91M SJ91N SJ91T SJ92E SJ92J SJ92M SJ92P
SJ92S SJ92U SJ92V SJ92W SJ92Z SJ93C SJ93E SJ93F SJ93G SJ93H SJ93I SJ93K
SJ93L SJ93M SJ93Q SJ93R SJ93S SJ93T SJ93U SJ93V SJ93W SJ93X SJ93Y SJ93Z
SJ94Q SJ94X SJ95P SJ96C SK00Z SK01Q SK01R SK01S SK01W SK01X SK02C SK02E
SK02G SK02H SK02I SK02J SK02L SK02M SK02N SK02P SK02S SK02T SK02U SK02V
SK02Y SK02Z SK03A SK03B SK03C SK03D SK03E SK03F SK03G SK03H SK03I SK03J
SK03K SK03L SK03M SK03N SK03P SK03Q SK03R SK03S SK03T SK03U SK03V SK03Y
SK03Z SK04C SK04D SK04M SK04Q SK04V SK11E SK12B SK12C SK12D SK12E SK12G
SK12I SK12J SK12L SK12M SK12N SK12R SK12T SK12U SK12W SK12X SK12Y SK13C
SK13E SK13F SK14A SK14B SK14G SK14M SK14N SK14P SK15F SK20J SK20N SK20U
SK21C SK22C SO77U SO78K SO78W SO88B SO88C SO88G SO89A SP09Z SP19P SP19U

BORDERLINE negatives (N= 10)
SJ74V SJ83J SJ83U SJ83Z SJ84H SJ84R SJ85T SJ94Q SJ94X SJ95P

MISCLASSIFIED negatives (N= 15)
SJ73Q SJ74Q SJ83E SJ83P SJ91T SJ92V SJ93T SK02P SK02T SK02U SK03P SK04D
SK04M SO77U SO88G

NEGATIVE PREFERENTIALS
Agri eupa1(50,6) Anag arve1(109,17) Arum macu1(202,23) Ball nigr1(67,8) Brac sylv1(137,22) Brom ramo1(144,22) Chae temu1(128,14) Cruc laev1(85,14) Gali veru1(84,11) Lact serr1(63,10) Meli unif1(66,10) Papa rhoe1(90,13)
Phle bert1(61,8) Pimp majo1(64,10) Prim vulg1(139,15) Sola nigr1(90,12) Tamu comm1(179,20)

Items in POSITIVE group 13 (N= 80) i.e.
84
group *101
SJ73G SJ73H SJ73I SJ73K SJ73L SJ73M SJ73N SJ73U SJ73Z SJ74Y SJ74Z SJ82A
SJ83Y SJ84E SJ84K SJ84V SJ84Z SJ85A SJ85G SJ85H SJ85N SJ85R SJ85S SJ85U
SJ85W SJ85X SJ85Y SJ85Z SJ91S SJ91U SJ91X SJ93D SJ93J SJ93N SJ93P SJ94A
SJ94D SJ94E SJ94F SJ94H SJ94I SJ94J SJ94L SJ94M SJ94N SJ94P SJ94T SJ94V

SJ94W SJ94Z SJ95A SJ95B SJ95E SJ95F SJ95G SJ95M SJ95N SJ95Q SJ95T SJ95U SJ95X SJ95Y SJ96F SJ96G SJ96L SK01C SK01D SK01I SK01K SK01L SK04A SK04B SK04F SK04G SK04H SK04J SK04K SK04L SK04R SO77P

BORDERLINE positives (N= 11)
SJ73G SJ73U SJ85N SJ93D SJ93P SJ94T SK01I SK01K SK04B SK04K SK04R

MISCLASSIFIED positives (N= 6)
SJ73Z SJ74Y SJ84V SJ84Z SJ94A SJ96G

POSITIVE PREFERENTIALS

Vero offi1(22,30) Achi ptar1(37,36) Aira prae1(14,19) Alch moll1(31,26) Alnu inca1(17,28) Aqui vulg1(17,17) Aren serp1(27,23) Blec spic1(28,51) Call vulg1(28,67) Care oval1(70,49) Care pilu1(13,25) Care vSSo1(8,19)

Cent eryt1(42,40) Cent mont1(15,18) Cera clav1(53,45) Cera tome1(14,23) Corn seri1(15,17) Croc pott1(38,43) Dact fuch1(32,42) Dact prae1(19,21) Dant decu1(9,283848) Desc flex1(102,78) Dryo cart1(20,18) Epil rose1(31,27)

Epip hell1(19,18) Equi fluv1(62,44) Equi sylv1(30,40) Eric cine1(10,19) Eric tetr1(6,19) Euph spec1(4,23) Fest ovin1(70,69) Fran alnu1(23,20) Gali saxa1(93,78) Hede hibe1(32,34) Hesp matr1(38,26) Hier acum1(20,31) Hier saba1(50,44) Hier vagu1(19,36) Hier vulg1(14,23) Hype humi1(22,18) Junc bulb1(13,22) Junc squa1(13,46) Lami gSSa1(66,46) Lami macu1(26,26) Lari xmar1(61,42) Lath lini1(26,26) Ligu oval1(56,44) Lina purp1(23,19) Lina vulg1(31,30) Linu cath1(17,23) Luzu mult1(39,52) Luzu pilo1(22,22) Luzu sylv1(28,29) Lysi punc1(46,52) Meco camb1(43,45) Ment spic1(32,22) Moli caer1(27,44) Myrr odor1(19,33) Nard stri1(19,53) Odon vern1(26,21) Oreo limb1(3,18) Pers bist1(50,42) Popu trem1(65,46) Prun padu1(54,38) Quer petr1(84,66) Quer rubr1(35,25) Quer xros1(47,35) Ranu flam1(83,66) Ranu hede1(21,18) Rhin mino1(21,24) Rosa rugo1(15,20) Sagi apet1(44,37) Sali pent1(21,22) Sali xrei1(36,24) Sedu acre1(30,28) Sedu rupe1(19,23) Sene visc1(45,31) Soli cana1(11,20) Sorb aria1(26,34) Sorb inte1(19,25) Spir spec1(28,40) Trif hybr1(54,44) Ulex gall1(56,63) Vacc myrt1(34,66)84 taxa

NON-PREFERENTIALS

Verb thap1(43,18) Vero agre1(84,36) Vero arve1(181,61) Vero becc1(211,73) Vero cham1(235,74) Vero fili1(55,25) Vero hede1(156,47) Vero mont1(135,42) Vero pers1(203,53) Vero serp1(177,64) Vibu opul1(176,68) Vici crac1(218,77)

Vici hirs1(135,42) Vici sepi1(219,77) Vici snig1(69,38) Vici sseg1(107,47) Viol arve1(137,26) Viol rivi1(192,56) Acer camp1(217,55) Acer plat1(75,39) Acer pseu1(237,79) Achi mill1(238,78) Adox mosc1(126,30) Aego poda1(212,75)

Aesc hipp1(177,63) Aeth cyna1(95,20) Agro cani1(55,32) Agro capi1(228,80) Agro giga1(111,37) Agro stol1(219,78) Ajug rept1(145,46) Alis plan1(116,37) Alli peti1(237,76) Alli ursi1(118,26) Alnu glut1(230,77) Alop geni1(190,67)

Alop prat1(230,78) Anem nemo1(131,42) Ange sylv1(210,69) Anis ster1(215,63) Anth odor1(219,79) Anth sylv1(240,78) Apha aust1(30,18) Apiu nodi1(170,34) Arab thal1(150,58) Arct minu1(224,66) Armo rust1(86,21) Arrh elat1(235,80)

Arte absi1(28,17) Arte vulg1(213,72) Aspl ruta1(37,17) Athy fili1(157,72) Atri patu1(208,70) Atri pros1(163,59) Aven fatu1(95,23) Barb vulg1(72,19) Bell pere1(238,79) Betu pend1(208,80) Betu pube1(141,77) Bras napu1(115,38)

Brom hord1(202,71) Budd davi1(43,27) Call spec1(160,65) Calt palu1(131,57) Caly sepi1(206,72) Caly silv1(140,60) Camp rotu1(96,51) Caps burs1(230,78) Card amar1(92,45) Card flex1(225,78) Card hirs1(196,69) Card prat1(199,75)

Care amis1(102,23) Care flac1(68,34) Care hirt1(151,52) Care nigr1(77,51) Care otru1(49,11) Care pani1(85,48) Care pata1(46,25) Care pend1(60,31) Care remo1(129,43) Care sylv1(78,27) Carp betu1(66,25) Cast sati1(150,54)

Cent nigr1(230,77) Cera font1(238,79) Cera glom1(208,74) Cham angu1(235,79) Chel maju1(106,41) Chen albu1(213,72) Chen rubr1(81,17) Chry oppo1(123,50) Circ lute1(170,45) Cirs arve1(240,80) Cirs palu1(198,78) Cirs vulg1(238,80)

Clay sibi1(54,34) Coch dani1(63,23) Coni macu1(56,10) Cono maju1(202,73) Conv arve1(76,18) Cony cana1(37,24) Corn sang1(96,25) Cory avel1(237,76) Crat mono1(239,80) Crep capi1(161,59) Cymb mura1(39,20) Cyno cris1(206,79)

Cyti scop1(123,72) Dact glom1(240,79) Desc cesp1(213,80) Digi purp1(232,79) Dips full1(74,41) Dryo affi1(58,38) Dryo dila1(226,79) Dryo fili1(235,80) Eleo palu1(65,26) Elym cani1(88,22) Elyt repe1(221,78) Epil cili1(199,71)

Epil hirs1(236,79) Epil obsc1(154,70) Epil palu1(72,32) Epil parv1(127,49) Epil xert1(207,80) Equi arve1(232,80) Equi palu1(94,42) Euph heli1(130,42) Euph pepl1(154,64) Fagu sylv1(207,73) Fall conv1(105,31) Fall japo1(89,55)

Fest arun1(113,48) Fest giga1(162,44) Fest prat1(80,28) Fest rubr1(227,80) Fili ulma1(228,68) Frag vesc1(73,27) Frax exce1(240,78) Fuma offi1(60,15) Gala niva1(59,13) Gale tagg1(212,70) Gali apar1(240,79) Gali odor1(51,25)

Gali palu1(185,71) Gera diss1(196,53) Gera luci1(82,52) Gera moll1(147,36) Gera robe1(238,78) Geum urba1(230,62) Glec hede1(225,51) Glyc decl1(73,39) Glyc flui1(182,67) Glyc maxi1(73,32) Glyc nota1(116,52) Gnap ulig1(146,38)
Hede heli1(239,76) Hera spho1(240,78) Holc lana1(239,79) Holc moll1(229,78) Hord muri1(53,16) Humu lupu1(79,14) Hyac non-1(221,77) Hyac xmas1(69,39) Hype perf1(93,41) Hype tetr1(112,33) Hypo radi1(226,79) Ilex aqui1(238,78)
Impa glan1(116,48) Iris pseu1(149,66) Junc acut1(109,53) Junc arti1(151,70) Junc bagg1(192,68) Junc cong1(128,68) Junc effu1(235,79) Junc infl1(191,54) Knau arve1(35,22) Lami albu1(234,61) Lami gSSm1(101,23) Lami purp1(211,56)
Laps comm1(236,76) Lari deci1(139,49) Lath prat1(226,76) Lemn mino1(169,57) Leon autu1(216,80) Leon hisp1(34,21) Leuc vulg1(148,66) Ligu vulg1(99,33) Loli mult1(116,45) Loli pere1(239,79) Loni peri1(230,77) Lotu corn1(213,79)
Lotu pedu1(177,75) Luna annu1(90,45) Luzu camp1(192,77) Lych flos1(98,43) Lyco euro1(104,45) Lysi nemo1(94,45) Lysi numm1(67,24) Malu pumi1(148,68) Malv mosc1(47,21) Malv sylv1(87,26) Matr disc1(233,78) Matr recu1(196,61)
Medi lupu1(164,76) Ment aqua1(126,48) Merc pere1(220,57) Mili effu1(89,19) Moeh trin1(156,43) Myce mura1(42,21) Myos arve1(207,67) Myos laxa1(121,47) Myos scor1(100,51) Myos sylv1(163,72) Nuph lute1(42,19) Nymp alba1(35,17)
Oxal acet1(166,64) Papa dubi1(80,29) Papa somn1(76,34) Pent semp1(86,26) Pers amph1(139,38) Pers hydr1(135,46) Pers lapa1(81,20) Pers macu1(223,78) Peta hybr1(76,33) Phal arun1(195,62) Phle prat1(230,77) Phyl scol1(86,40)
Pice abie1(80,23) Pilo aura1(56,29) Pilo offi1(126,68) Pimp saxi1(40,20) Pinu sylv1(163,65) Plan lanc1(238,79) Plan majo1(239,80) Poa annu1(237,79) Poa nemo1(65,19) Poa prat1(201,73) Poa triv1(235,79) Pold vule1(53,20) Poly aren1(145,50) Poly avic1(229,77) Popu alba1(37,22) Popu nIta1(59,17) Popu xcan1(93,32) Pota nata1(80,41) Pote anse1(185,42) Pote erec1(147,77) Pote rept1(210,61) Pote ster1(140,39) Prim veri1(56,16) Prun aviu1(182,63)
Prun dome1(186,59) Prun laur1(65,34) Prun spin1(233,76) Prun vulg1(208,75) Pter aqui1(214,79) Quer cerr1(59,33) Quer robu1(239,80) Ranu acri1(232,79) Ranu bulb1(146,50) Ranu fica1(214,65) Ranu fSSb1(115,33) Ranu repe1(240,80)
Ranu scel1(149,25) Raph raph1(49,13) Rese lula1(55,30) Rhod pont1(131,66) Ribe nigr1(43,18) Ribe rubr1(111,29) Ribe uva-1(161,52) Rori nagg1(113,46) Rori palu1(68,20) Rosa arve1(219,67) Rosa caes1(30,19) Rosa cagg1(233,78)
Rubu frut1(240,80) Rubu idae1(185,77) Rume acet1(226,79) Rume alla1(169,77) Rume cong1(133,32) Rume cris1(216,74) Rume hydr1(48,19) Rume obtu1(239,80) Rume sang1(212,50) Sagi proc1(175,76) Sali alba1(74,23) Sali capr1(219,80)
Sali cine1(217,80) Sali frag1(222,69) Sali vimi1(84,49) Sali xsmi1(43,18) Samb nigr1(240,80) Sang offi1(83,25) Scro auri1(84,20) Scro nodo1(179,71) Scut gale1(45,22) Sedu albu1(34,20) Sene aqua1(66,29) Sene jaco1(228,79)
Sene squa1(42,25) Sene vulg1(232,77) Sile dioi1(237,72) Sile lati1(69,27) Sina arve1(113,31) Sisy offi1(200,65) Sola dulc1(226,78) Sonc arve1(170,53) Sonc aspe1(232,79) Sonc oler1(224,75) Sorb aucu1(196,79) Spar erec1(137,50)
Sper arve1(50,17) Stac offi1(80,24) Stac palu1(57,28) Stac sylv1(236,78) Stel alsi1(167,73) Stel gram1(192,67) Stel holo1(225,75) Stel medi1(239,79) Succ prat1(92,56) Symp albu1(165,59) Symp xupl1(123,57) Syri vulg1(84,26)
Tana part1(109,62) Tana vulg1(51,21) Tara offi1(238,79) Taxu bacc1(144,46) Teuc scor1(107,48) Tili xeur1(155,64) Tori japo1(141,33) Trag prat1(97,39) Trif dubi1(203,74) Trif medi1(95,52) Trif prat1(232,79) Trif repe1(238,79)
Trip inod1(213,69) Tris flav1(105,42) Tuss farf1(197,78) Typh lati1(159,64) Ulex euro1(174,73) Ulmu glab1(222,70) Ulmu proc1(96,17) Urti dioi1(240,80) Urti uren1(70,20) Vale offi1(145,62)

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DIVISION 7 (N= 103) I.E. GROUP *11
Eigenvalue 0.124 at iteration 2
INDICATORS,together with their SIGN
Koel macr1(+) Thym poly1(+) Apha arve1(+) Card nuta1(+) Sang mmin1(+) Vacc myrt1(-) Heli numm1(+)
Maximum indicator score for negative group 4 Minimum indicator score for positive group 5

Items in NEGATIVE group 14 (N= 82) i.e.
group *110
SJ86V SJ91Y SJ91Z SJ94R SJ94S SJ94U SJ94Y SJ95C SJ95D SJ95H SJ95I SJ95J
SJ95K SJ95L SJ95R SJ95S SJ95V SJ95W SJ95Z SJ96A SJ96B SJ96K SJ96Q SJ96R
SJ96S SJ96V SJ96W SJ96X SK01E SK04E SK04I SK04N SK04P SK04S SK04T SK04U
SK04W SK04X SK05A SK05B SK05C SK05D SK05E SK05F SK05G SK05H SK05I SK05J
SK05K SK05L SK05M SK05N SK05P SK05Q SK05R SK05S SK05T SK05U SK06A SK06B

SK06C SK06D SK06F SK06G SK06H SK06I SK06J SK06K SK06L SK06M SK06N SK06Q
SK06R SK06S SK06T SK06V SK06W SK06X SK14H SK15J SK16A SK16B

BORDERLINE negatives (N= 2)
SK14H SK15J

NEGATIVE PREFERENTIALS
Viol palu1(46,2) Achi ptar1(63,7) Agro cani1(47,2) Agro vine1(24,2) Blec spic1(73,4) Bras napu1(18,1) Call spec1(68,6) Call vulg1(72,6) Caly silv1(24,1) Card amar1(51,6) Care amis1(24,2) Care bine1(27,1) Care echi1(32,2) Care nigr1(71,6) Care oval1(66,7) Care pata1(20,1) Care pilu1(25,3) Care rost1(17,0) Care vSSo1(38,3) Cast sati1(24,3) Cera clav1(30,1) Cera tome1(27,3) Crep palu1(26,1) Croc pott1(21,0) Cyti scop1(34,3) Desc flex1(81,7) Dryo affi1(31,2) Empe nigr1(25,0) Epil obsc1(73,7) Epil palu1(64,6)
Equi fluv1(57,6) Equi palu1(51,5) Equi sylv1(67,2) Eric tetr1(27,3) Erio angu1(32,2) Erio vagi1(26,0) Fall japo1(36,2) Gali palu1(81,10) Glyc decl1(40,5) Glyc maxi1(18,2) Gnap ulig1(29,0) Hier acum1(31,2) Hier saba1(29,1) Hier vulg1(18,2) Hype pulc1(41,4) Iris pseu1(55,4) Junc acut1(72,9) Junc arti1(79,10) Junc bulb1(41,1) Junc cong1(76,9) Junc squa1(58,2) Lari xmar1(25,2) Loli mult1(30,3) Luzu mult1(63,4) Lysi numm1(20,2) Lysi punc1(39,3) Malu pumi1(45,4) Ment spic1(26,3) Moli caer1(62,3) Mont font1(51,2)
Myos laxa1(56,5) Myos secu1(41,1) Nard stri1(76,5) Oreo limb1(56,1) Pers amph1(17,1) Pers hydr1(32,3) Pers macu1(69,7) Pice abie1(22,2) Pice sitc1(17,1) Prun dome1(36,4) Pter aqui1(75,7) Quer petr1(42,4) Quer xros1(31,1) Ranu hede1(35,4) Ranu omio1(31,2) Rhod pont1(40,2) Rosa sher1(17,1) Rume alla1(79,9) Rume alpi1(23,0) Rume cong1(24,3) Sali auri1(43,3) Sali pent1(41,3) Sali xmul1(38,0) Sali xrei1(23,1) Sisy offi1(37,3) Sola dulc1(34,1) Spir spec1(23,1) Stac palu1(20,2) Trig palu1(24,1) Vacc myrt1(79,4)
Vacc viti1(37,1) Vale dioi1(40,4)

Items in POSITIVE group 15 (N= 21) i.e.
group *111
SK04Y SK04Z SK05V SK05W SK05X SK05Y SK05Z SK14C SK14D SK14E SK14I SK14J
SK15A SK15B SK15C SK15D SK15E SK15G SK15H SK15I SK15K

BORDERLINE positives (N= 1)
SK14D

MISCLASSIFIED positives (N= 1)
SK05V

POSITIVE PREFERENTIALS
Vero arve1(30,20) Vero fili1(9,6) Vero hede1(17,15) Viol reic1(2,10) Acer camp1(32,17) Adox mosc1(26,14) Agri eupa1(2,6) Aira cary1(1,9) Alch fili1(24,13) Alli ursi1(20,16) Anth vuln1(3,7) Apha arve1(3,19) Arab hirs1(2,15) Aren serp1(16,20) Arum macu1(14,18) Aspl ruta1(6,16) Aspl tric1(6,15) Barb vulg1(9,7) Brac sylv1(14,16) Bras rapa1(8,5) Brom erec1(1,5) Brom ramo1(16,16) Camp lati1(9,15) Card cris1(0,8) Card nuta1(5,19) Carl vulg1(2,12) Cent scab1(3,6) Cera semi1(2,5) Chae temu1(5,8) Chel maju1(10,6)
Chry alte1(8,10) Cirs acau1(0,6) Cirs hete1(8,5) Corn sang1(12,16) Crep capi1(24,17) Cruc laev1(31,21) Cyst frag1(2,14) Drab mura1(1,6) Elym cani1(18,11) Erop vern1(14,20) Fest xper1(11,6) Frag vesc1(24,16) Gala niva1(10,8) Gali odor1(16,14) Gali ster1(2,15) Gali veru1(25,21) Gent amar1(2,6) Gera colu1(0,8) Gera diss1(12,16) Gera moll1(13,15) Geum xint1(2,6) Gymn cono1(2,5) Heli numm1(2,18) Heli prat1(3,10) Heli pube1(6,16) Hype hirs1(3,15) Hype perf1(10,10) Knau arve1(21,14) Koel macr1(3,21) Lami gSSm1(10,16) Lath squa1(3,7) Linu cath1(30,21) List ovat1(9,8) Malv mosc1(6,5) Meli unif1(8,8) Mili effu1(8,5) Moeh trin1(19,13) Myce mura1(18,16) Myos ramo1(0,7) Ophi vulg1(11,6) Orch masc1(3,16) Orig vulg1(3,10)
Papa somn1(9,5) Phle bert1(20,17) Pimp majo1(32,20) Pimp saxi1(20,17) Plan medi1(7,18) Poa nemo1(10,7) Pold vule1(23,17) Polg vuls1(11,14) Poly acul1(4,10) Pote anse1(39,20) Pote tabe1(0,7) Prim veri1(15,16) Prim xpol1(2,5) Ranu auri1(2,12) Ranu fSSb1(21,14) Rham cath1(1,7) Ribe alpi1(7,13) Sang mmin1(5,19) Sani euro1(6,7) Saxi gran1(15,18) Saxi hypn1(1,6) Saxi trid1(2,18) Scab colu1(4,16) Sedu acre1(26,18) Sedu tele1(6,7) Sher arve1(0,7) Stac offi1(27,18) Tamu comm1(2,10) Thym poly1(6,20) Tori japo1(37,19)
Trag prat1(22,16) **103 taxa**

NON-PREFERENTIALS (***deleted to save space***)
End of level 3

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DIVISION 8 (N= 61) I.E. GROUP *000
Eigenvalue 0.076 at iteration 2
INDICATORS,together with their SIGN

Care remo1(-) Coto diel1(-) Quer xros1(-) Ajug rept1(-)
Maximum indicator score for negative group -4 Minimum indicator score for positive group -3

Items in NEGATIVE group 16 (N= 5) i.e.
group *0000
SO88Y SO88Z SO89R SO89V SO89Y

NEGATIVE PREFERENTIALS
Verb bona1(3,7) Vero becc1(5,19) Vero fili1(5,17) Vero mont1(2,2) Vero poli1(2,4) Vibu tinu1(3,1) Vici snig1(4,18) Vinc majo1(4,13) Vinc mino1(4,9) Viol odor1(2,5) Viol rivi1(5,25) Visc albu1(2,6) Agri eupa1(2,4) Ajug rept1(5,5) Alce rose1(2,4) Alch moll1(5,23) Alli triq1(2,0) Alli ursi1(2,11) Alli vine1(2,6) Alnu xhyb1(3,2) Alys saxa1(3,5) Amel lama1(2,3) Anch arve1(5,22) Ange sylv1(4,22) Anti maju1(5,28) Apha arve1(4,17) Arum ital1(2,3) Arum macu1(5,15) Aspa offi1(2,2) Aspl ruta1(4,22) Aste xsal1(2,6) Aubr delt1(3,3) Aucu japo1(3,3) Aven sati1(5,19) Ball nigr1(5,20) Berb darw1(3,4) Berb gagn1(2,0) Berb juli1(4,2) Berb thun1(2,5) Berb xste1(2,0) Bora offi1(4,10) Brac sylv1(5,14) Bras nigr1(4,9) Bras oler1(2,3) Briz maxi1(3,2) Brom ramo1(5,9) Call spec1(5,25) Camp pers1(4,20) Camp port1(3,9) Camp posc1(5,15) Care amis1(3,10) Care muri1(2,7) Care pend1(4,19) Care remo1(5,2) Care spic1(2,5) Care sylv1(2,4) Carp betu1(5,23) Cast sati1(5,19) Cent mont1(5,11) Cent rube1(5,28) Chae temu1(5,13) Cham laws1(5,10) Chen fici1(2,1) Chry oppo1(2,0) Cich inty1(2,7) Circ lute1(5,11) Clin asce1(2,0) Coch dani1(5,27) Cono maju1(5,24) Cons ajac1(2,1) Conv maja1(3,4) Cony bona1(2,1) Cony suma1(3,12) Corn seri1(3,14) Coto bull1(4,6) Coto diel1(5,4) Coto diva1(2,1) Coto fran1(5,6) Coto hjel1(4,2) Coto hori1(5,24) Coto lact1(2,2) Coto rehd1(4,20) Coto sali1(4,17) Coto simo1(5,17) Coto ster1(2,3) Coto xsue1(3,1) Coto xwat1(3,8) Crat xmed1(3,0) Croc pott1(5,26) Croc tomm1(2,5) Croc vern1(2,6) Cymb mura1(5,24) Echi crus1(2,8) Elod cana1(2,7) Elym cani1(2,10) Epil tetr1(3,12) Equi palu1(2,3) Erig karv1(3,3) Erys chri1(5,21) Euon euro1(2,5) Euph amyg1(2,5) Euph cypa1(3,4) Euph lath1(2,6) Fest giga1(5,13) Fest rSSm1(2,1) Fors xint1(4,4) Frag vesc1(4,10) Fuma mura1(3,9) Gala niva1(5,5) Gala woro1(2,0) Gali odor1(2,3) Gali palu1(2,7) Gera xoxo1(4,18) Glec hede1(5,19) Glyc flui1(3,16) Hede cana1(3,3) Hede hibe1(4,19) Hell argu1(2,0) Heuc sang1(4,2) Hier scot1(2,1) Hord vulg1(2,2) Humu lupu1(3,14) Hyac hisp1(3,14) Hype andr1(5,12) Hype caly1(5,5) Hype humi1(2,3) Iber umbe1(3,7) Ilex xalt1(2,2) Impa wall1(2,0) Iris foet1(2,4) Iris germ1(2,2) Kerr japo1(3,4) Lami gSSa1(4,13) Lava angu1(2,3) Leon hisp1(3,7) Leyc form1(3,4) Ligu vulg1(4,19) Linu usit1(3,16) Lobe erin1(5,11) Loli mult1(5,12) Loni japo1(3,3) Loni niti1(2,4) Lych coro1(5,19) Lysi nemo1(2,1) Lyth sali1(4,14) Maho aqui1(5,16) Malv negl1(4,5) Ment arve1(2,2) Ment spic1(3,16) Ment xvsa1(2,4) Merc pere1(5,12) Mili effu1(3,4) Moeh trin1(4,6) Mssa offi1(5,11) Musc arme1(4,15) Myce mura1(5,18) Myos aqua1(2,6) Myos scor1(4,15) Narc pseu1(3,2) Nige dama1(2,10) Oeno bien1(3,10) Orni perp1(2,5) Oxal acet1(4,3) Oxal arti1(3,1) Oxal corn1(5,23) Oxal debi1(2,2) Oxal exil1(5,12) Oxal stri1(2,4) Paeo offi1(2,1) Pani mili1(3,6) Papa orie1(2,6) Pers hydr1(3,6) Pers lapa1(5,20) Peta hybr1(5,18) Petu axil1(2,3) Phil coro1(3,4) Picr echi1(3,13) Plan coro1(3,11) Poa humi1(4,14) Poa nemo1(4,8) Pold vule1(2,5) Popu nigr1(3,2) Popu nSSb1(3,4) Pote angl1(2,3) Pote anse1(5,22) Pote frut1(2,0) Pote ster1(4,5) Pote xmix1(4,1) Prim vulg1(3,7) Prun cera1(2,7) Prun dome1(5,20) Pseu lute1(5,27) Pucc dist1(3,6) Pyru comm1(2,9) Quer xros1(5,4) Ranu fSSb1(5,12) Rhod pont1(4,17) Rhus typh1(3,14) Ribe nigr1(2,7) Ribe rubr1(4,13) Ribe sang1(5,25) Ribe uva-1(4,14) Rori nagg1(5,21) Rosa ferr1(3,3) Rubu laci1(3,3) Rubu tric1(2,2) Rume sang1(5,15) Ruta grav1(2,1) Sali daph1(2,0) Sali xrei1(2,5) Sali xrub1(2,3) Scho lacu1(3,11) Scro auri1(4,12) Sedu spec1(2,8) Sene aqua1(2,5) Sher arve1(3,7) Sole sole1(2,9) Soli giga1(3,14) Sper arve1(4,20) Spir spec1(5,18) Stac arve1(2,10) Stac byza1(2,3) Stac offi1(3,6) Stel holo1(4,9) Tamu comm1(3,4) Taxu bacc1(5,26) Tell gran1(2,5) Teuc scor1(2,11) Thla arve1(3,12) Tori japo1(4,19) Trif micr1(4,5) Trif stri1(3,2) Tris flav1(5,24) Trop maju1(2,4) Ulex gall1(3,12) Ulmu proc1(5,20) Ulmu xhol1(4,3) Vale locu1(2,7)

Items in POSITIVE group 17 (N= 56) i.e.
group *0001
SJ80V SJ84N SJ84P SJ84S SJ84T SJ84U SJ84Y SJ90A SJ90F SJ90K SJ94B SK00A
SK00B SK01B SK10J SO88S SO88U SO88X SO98D SO98N SO98P SO98U SO99D SO99E
SO99H SO99I SO99J SO99K SO99L SO99M SO99N SO99P SO99Q SO99R SO99S SO99T
SO99U SO99V SO99W SO99X SO99Y SO99Z SP08E SP08J SP09A SP09B SP09C SP09D
SP09F SP09K SP09L SP09Q SP09R SP09S SP09T SP09X

BORDERLINE positives (N= 1)
SO99D

POSITIVE PREFERENTIALS
Alis lanc1(0,27) Anth vuln1(0,19) Chen rubr1(0,12) Coni macu1(1,34) Corn alba1(0,17) Dauc caro1(1,47) Dipl tenu1(0,15) Erig acer1(1,24) Eupa cann1(0,18) Gera sang1(0,12) Hier salt1(0,17) Hirs inca1(1,27) Meli albu1(0,35) Sagi sagi1(1,24) Sang offi1(0,16) Spar emer1(0,25) Trif hybr1(2,46)

NON-PREFERENTIALS (***deleted to save space***)

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DIVISION 9 (N= 18) I.E. GROUP *001
Eigenvalue 0.103 at iteration 5
INDICATORS,together with their SIGN
Cent rube1(-) Hirs inca1(-) Impa glan1(-)
Maximum indicator score for negative group -2 Minimum indicator score for positive group -1

Items in NEGATIVE group 18 (N= 7) i.e.
group *0010
SJ84X SJ85K SJ92B SO98E SO98I SO98J SP09G
NEGATIVE PREFERENTIALS
Verb lych1(2,0) Vero cate1(2,0) Vero fili1(3,1) Vero serp1(6,2) Vibu lant1(2,1) Vinc mino1(3,1) Viol reic1(2,0) Viol tric1(2,1) Viol xwit1(4,3) Agri eupa1(3,1) Agro gith1(2,0) Ajug rept1(4,1) Alch moll1(4,1) Alop myos1(2,0) Amar retr1(2,0) Anac pyra1(2,1) Anem nemo1(3,2) Apha aust1(3,0) Aqui vulg1(4,3) Arct lapp1(2,0) Arum macu1(4,1) Aspa offi1(2,1) Aspl ruta1(4,3) Aste laev1(2,0) Aste xsal1(3,0) Aven fatu1(5,3) Aven sati1(3,2) Barb vern1(2,0) Barb vulg1(5,3) Berb darw1(2,1) Bide cern1(2,0) Brac sylv1(4,1) Bras napu1(6,3) Bras nigr1(2,1) Bras oler1(2,0) Briz medi1(2,1) Brom ramo1(4,1) Buxu semp1(2,1) Cale offi1(3,1) Camp pers1(3,0) Card amar1(2,1) Card cris1(3,1) Card nuta1(4,3) Care dist1(2,1) Care muri1(3,2) Care pend1(5,3) Cata rigi1(4,0) Cent mont1(2,1) Cent rube1(6,1) Cent scab1(3,2) Cera clav1(3,1) Cera semi1(2,1) Chae minu1(4,3) Chae temu1(4,2) Chen rubr1(4,3) Chry oppo1(2,1) Cich inty1(3,1) Circ lute1(2,1) Clem vita1(3,1) Coin mone1(2,0) Coro didy1(6,3) Coto bull1(2,0) Coto diel1(2,1) Coto hori1(4,2) Coto xwat1(3,2) Cymb mura1(5,3) Dact xgra1(3,2) Digi sang1(2,0) Dipl mura1(4,1) Dryo affi1(4,3) Echi crus1(2,0) Echi vulg1(2,1) Elod cana1(4,1) Elym cani1(2,0) Epil tetr1(4,3) Epip hell1(3,1) Erig acer1(4,3) Erod cicu1(5,3) Erop vern1(6,3) Esch cali1(3,1) Euon euro1(3,0) Fest giga1(4,1) Fila vulg1(2,1) Fili vulg1(2,1) Frag vesc1(4,2) Fuma mura1(3,1) Gala niva1(2,1) Gale offi1(2,1) Gali odor1(2,0) Gera endr1(2,0) Gera prat1(6,4) Gera sang1(4,0) Gera xoxo1(3,1) Geum riva1(3,0) Geum urba1(7,5) Hede hibe1(4,2) Heli annu1(3,1) Hera mant1(3,1) Hirs inca1(6,1) Humu lupu1(4,1) Hyac hisp1(3,1) Hype andr1(4,0) Hype hirc1(2,0) Hype macu1(2,0) Hype pulc1(2,0) Impa glan1(7,3) Inul cony1(2,0) Iris germ1(3,0) Isol seta1(4,3) Lami gSSa1(4,2) Lath lati1(2,1) Lath niss1(2,1) Lava thur1(2,1) Leon hisp1(4,2) Lepi rude1(3,1) Ligu vulg1(3,2) Linu usit1(4,0) Loli mult1(4,3) Lych coro1(3,2) Lyco escu1(3,0) Lysi numm1(5,3) Lyth sali1(6,4) Maho aqui1(3,2) Meco camb1(3,2) Meli unif1(2,0) Ment spic1(4,3) Merc pere1(5,3) Mili effu1(2,1) Mono hypo1(2,0) Musc arme1(2,0) Myce mura1(2,1) Myos aqua1(2,0) Myri aqua1(2,1) Nymp pelt1(3,1) Oeno bien1(3,0) Oeno fall1(2,0) Onob vici1(4,0) Orig vulg1(4,0) Pani mili1(2,0) Pent semp1(6,4) Pers bist1(4,0) Phal cana1(4,2) Picr hier1(2,0) Poa comp1(2,0) Poly seti1(2,0) Popu tric1(2,0) Pote angl1(4,3) Pote arge1(2,0) Pote ster1(2,1) Pote xmix1(4,3) Prim vulg1(3,1) Prun laur1(5,2) Pseu lute1(3,2) Pyra cocc1(2,0) Pyru comm1(5,2) Ranu bulb1(4,2) Ranu fSSb1(3,1) Ranu ling1(5,2) Raph sati1(2,0) Rhod pont1(3,1) Ribe rubr1(4,1) Rosa ferr1(2,1) Rume sang1(5,3) Sali alba1(7,5) Sali pent1(2,1) Sali purp1(2,1) Sali xrub1(2,0) Salv verb1(2,0) Sang mmin1(3,0) Saxi xurb1(2,1) Scro auri1(6,2) Sedu albu1(6,4) Sedu rupe1(6,3) Sedu spur1(3,0) Seta pumi1(2,0) Seta viri1(2,0) Sher arve1(2,0) Soli cana1(6,2) Soli giga1(2,0) Sper arve1(5,3) Stac offi1(4,1) Stel alsi1(5,3) Stel holo1(5,3) Succ prat1(4,1) Symp offi1(4,3) Tamu comm1(4,2) Thla arve1(4,2) Tori japo1(6,4) Trif arve1(6,3) Trit aest1(6,4) Ulmu proc1(3,2) Vale offi1(3,0)

Items in POSITIVE group 19 (N= 11) i.e.
group *0011
SJ84W SJ90V SK00C SK00G SK00I SK00J SK00K SK00L SK00M SK00N SP09E

POSITIVE PREFERENTIALS
Alop aequ1(0,3) Anch arve1(0,3) Aspl adia1(0,4) Azol fili1(0,3) Betu xaur1(0,3) Blec spic1(1,4) Care echi1(1,4) Care pani1(2,7) Care pseu1(1,7) Care rost1(0,3) Cera deme1(2,7) Cirs diss1(0,3) Cras helm1(1,4) Dant decu1(0,3) Eric cine1(0,3) Eric tetr1(0,5) Erio angu1(0,5) Gera rotu1(0,3) Hydr vulg1(1,5) Junc bulb1(1,5) Junc squa1(0,4) Junc tenu1(2,7) Lact viro1(0,3) Lami hybr1(1,6) Lemn minu1(2,9) Linu cath1(3,10) Litt unif1(0,3) Lotu cSSs1(0,3) Luro nata1(0,6) Moli caer1(1,6) Nard stri1(2,8) Nuph lute1(2,8) Nymp alba1(2,8) Onon repe1(1,4) Oreo limb1(0,3) Pota luce1(0,7) Pota perf1(2,8) Quer petr1(1,5) Quer rubr1(1,4) Sali baby1(1,4) Sali xrei1(1,7) Sene aqua1(1,6) Sene eruc1(1,6) Trig palu1(0,4) Vacc myrt1(0,5) Vacc oxyc1(0,3)

NON-PREFERENTIALS (***deleted to save space***)
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DIVISION 10 (N= 71) I.E. GROUP *010
Eigenvalue 0.055 at iteration 3
INDICATORS,together with their SIGN
Arum macu1(+) Tamu comm1(+) Brac sylv1(+) Glec hede1(+)
Maximum indicator score for negative group 1 Minimum indicator score for positive group 2

Items in NEGATIVE group 20 (N= 28) i.e.
group *0100
SJ84I SJ84J SJ85F SJ85L SJ85M SJ85Q SJ85V SJ90Q SJ90S SJ90T SJ90W SJ90X
SJ90Z SJ91Q SJ91R SJ91V SJ91W SJ92H SJ94C SJ94G SJ94K SK00E SK00H SK00P
SK01A SK01F SK01G SO98T

BORDERLINE negatives (N= 2) SJ94K SO98T
NEGATIVE PREFERENTIALS
Aira cary1(7,3) Alnu cord1(10,5) Alnu inca1(20,14) Care spic1(7,5) Chae minu1(8,5) Corn alba1(9,4) Corn seri1(14,3) Cras helm1(8,4) Dact xgra1(6,3) Euph spec1(7,3) Fuma mura1(8,5) Hier acum1(9,5) Hier saba1(13,9) Hier salt1(6,3) Hier vagu1(9,3) Hier vulg1(9,6) Hirs inca1(6,1) Junc squa1(6,1) Lami hybr1(7,4) Medi sati1(11,7) Moli caer1(7,2) Nard stri1(13,6) Pota nata1(15,8) Prun cera1(8,4) Rosa rubi1(8,3) Rosa spin1(6,3) Rume xpra1(10,1) Sali auri1(6,2) Sper mari1(6,3) Vacc myrt1(10,4)

Items in POSITIVE group 21 (N= 43) i.e. **group *0101**
SJ80W SJ82F SJ82X SJ83L SJ84D SJ90J SJ91H SJ92C SJ92F SJ92G SK00F SK01N
SK02A SK03W SK10E SK10S SK11A SK20A SK20B SK20C SK20F SK20G SK20H SK22A

SK22G SK22L SK22M SK22R SO89L SO89Q SO89T SO89U SO89W SO89X SO98C SO99A
SO99B SO99C SO99F SO99G SP09H SP09I SP09M

BORDERLINE positives (N= 4) SJ84D SK00F SK20F SP09M

MISCLASSIFIED positives (N= 3) SJ83L SJ92G SK22M

POSITIVE PREFERENTIALS
Vero cate1(0,11) Vero mont1(3,19) Vinc majo1(3,11) Viol odor1(0,18) Viol rivi1(10,37) Adox mosc1(0,13) Agri eupa1(1,10) Ajug rept1(5,21) Alli ursi1(2,24) Anem nemo1(5,23) Apha arve1(2,15) Apiu nodi1(12,38) Arum macu1(4,39) Aspl ruta1(3,27) Aspl tric1(2,15) Ball nigr1(5,28) Bide fron1(1,11) Bide trip1(2,17) Brac sylv1(0,29) Briz medi1(1,9) Brom ramo1(3,29) Bryo dioi1(5,26) Card amar1(5,19) Card nuta1(3,14) Care amis1(6,32) Care pata1(0,13) Care ripa1(2,19) Care sylv1(3,12) Cent rube1(5,22) Cera tome1(5,16) Chae temu1(2,24) Cham laws1(1,12) Chry oppo1(2,16) Coni macu1(7,25) Cymb mura1(4,20) Elym cani1(4,15) Equi palu1(6,20) Erig acer1(3,10) Erod cicu1(7,22) Eupa cann1(2,11) Fall bald1(3,11) Fest giga1(5,27) Fest prat1(4,15) Fila vulg1(0,9) Fili ulma1(12,39) Frag vesc1(5,19) Gala niva1(1,12) Gali quad1(2,10) Gera pusi1(9,34) Glec hede1(5,38) Humu lupu1(3,24) Hyac hisp1(2,10) Impa cape1(1,16) Impa glan1(6,32) Lami gSSm1(1,10) Leon hisp1(3,13) Lepi drab1(1,11) Ligu vulg1(9,31) Lobu mari1(4,14) Maho aqui1(3,15) Malv mosc1(10,33) Malv negl1(2,15) Meli unif1(0,13) Merc pere1(7,34) Mili effu1(3,10) Moeh trin1(3,20) Myce mura1(2,14) Myos aqua1(2,17) Myos disc1(2,9) Myos scor1(11,36) Narc pseu1(0,10) Oena croc1(4,21) Oxal acet1(1,14) Oxal corn1(6,28) Oxal exil1(2,16) Pari juda1(1,10) Pent semp1(10,35) Pers bist1(3,13) Pers hydr1(3,28) Peta hybr1(4,21) Phyl scol1(9,31) Plat xhis1(3,13) Poa nemo1(3,16) Pold vule1(1,11) Popu nSSb1(3,10) Pote ster1(2,18) Prim vulg1(3,19) Pseu lute1(1,23) Pyru comm1(3,10) Quer cerr1(3,13) Ranu fSSb1(3,15) Ribe rubr1(4,21) Ribe uva-1(7,22) Rori amph1(2,12) Rori palu1(6,19) Rume hydr1(7,26) Rume sang1(11,36) Sagi sagi1(2,10) Sali baby1(1,12) Scro auri1(4,30) Scut gale1(7,25) Sedu acre1(7,32) Sene aqua1(2,11) Sole sole1(0,9) Spar emer1(4,17) Stac offi1(3,12) Stac palu1(3,24) Tamu comm1(1,29) Taxu bacc1(10,37) Thla arve1(4,14) Ulmu glab1(11,41) Ulmu proc1(5,29)

NON-PREFERENTIALS (***deleted to save space***)
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DIVISION 11 (N= 240) I.E. GROUP *011
Eigenvalue 0.038 at iteration 4
INDICATORS,together with their SIGN
Cirs palu1(-) Glyc flui1(-) Gali palu1(-) Spar erec1(-) Glyc maxi1(-) Vale offi1(-)
Maximum indicator score for negative group -3 Minimum indicator score for positive group -2

Items in NEGATIVE group 22 (N= 141) i.e. **group *0110**
SJ71U SJ71Z SJ72K SJ72N SJ72T SJ72V SJ72W SJ80K SJ80L SJ80M SJ80Q SJ80U
SJ80Y SJ80Z SJ81R SJ81S SJ81W SJ81X SJ81Z SJ82P SJ82R SJ82T SJ82V SJ82W
SJ82Y SJ83F SJ83T SJ83X SJ84Q SJ90E SJ90G SJ90I SJ90M SJ90N SJ90P SJ90R
SJ90U SJ91C SJ91D SJ91F SJ91G SJ91I SJ91J SJ91L SJ91P SJ92A SJ92D SJ92I
SJ92K SJ92L SJ92Q SJ92R SJ92T SJ92X SJ92Y SJ93A SJ93B SK00D SK01H SK01J
SK01T SK01V SK01Y SK02B SK02D SK02F SK02K SK02W SK02X SK03X SK10G SK10I
SK10L SK10P SK10R SK10U SK10W SK10X SK10Y SK11B SK11C SK11D SK11G SK11I
SK11J SK11K SK11L SK11N SK11P SK11Q SK11R SK11S SK11T SK11U SK11W SK11X

SK11Y SK11Z SK12F SK12H SK12K SK12P SK12Q SK12V SK12Z SK13A SK13B SK13K SK13Q SK20M SK21A SK21E SK21K SK22B SK22E SK22F SK22I SK22J SK22N SK22S SK22T SO78Q SO78V SO78Y SO79Z SO88D SO88E SO88H SO88I SO88J SO88M SO89F SO89I SO89K SO89M SO89N SO89S SO98M SP09J SP09P SP29E

BORDERLINE negatives (N= 24)
SJ72T SJ81Z SJ90G SJ90I SJ90M SJ90N SJ90P SJ90R SJ91C SK01H SK01V SK02B SK10G SK10L SK11K SK11R SK11U SK13Q SO78Y SO79Z SO88H SO89F SO89K SP29E

MISCLASSIFIED negatives (N= 9) SJ80U SJ81W SJ84Q SK02K SK10R SK11B SK12P SK12V SO98M
NEGATIVE PREFERENTIALS
Vero cate1(32,1) Vero mont1(59,13) Vici tetr1(34,10) Agri eupa1(33,10) Agro cani1(37,10) Ajug rept1(61,16) Alis plan1(78,25) Anem nemo1(51,17) Ange sylv1(119,41) Apha aust1(37,11) Brac sylv1(93,32) Calt palu1(73,16) Card amar1(50,12) Card cris1(40,9) Care amis1(81,17) Care nigr1(33,6) Care otru1(67,15) Care pata1(31,4) Care ripa1(40,10) Chry oppo1(39,9) Cirs palu1(114,26) Coro squa1(38,13) Cruc laev1(33,9) Dauc caro1(35,12) Eleo palu1(49,8) Elod cana1(31,4) Epil palu1(43,6) Epil rose1(33,8) Equi fluv1(37,2) Equi palu1(42,5) Fest giga1(72,15) Fest prat1(43,13) Frag vesc1(33,9) Gali palu1(105,21) Glyc flui1(103,17) Glyc maxi1(94,21) Glyc nota1(50,8) Hype tetr1(57,12) Impa cape1(41,10) Junc acut1(52,6) Junc arti1(88,20) Lotu pedu1(96,33) Lych flos1(46,6) Lysi numm1(50,11) Lyth sali1(33,8) Maho aqui1(35,12) Meli unif1(31,6) Ment aqua1(95,33) Myos aqua1(45,10) Myos laxa1(58,13) Myos scor1(95,28) Nuph lute1(35,8) Oena croc1(39,11) Pers hydr1(84,28) Phra aust1(73,13) Pota nata1(38,6) Pota pect1(37,7) Pote erec1(58,11) Prim veri1(46,6) Prim vulg1(69,22) Ranu flam1(31,3) Ribe rubr1(62,19) Rori amph1(29,3) Rori nagg1(90,24) Rume hydr1(70,12) Sali vimi1(80,28) Sang offi1(45,8) Scut gale1(48,10) Sene aqua1(42,2) Spar emer1(35,6) Spar erec1(104,25) Stac palu1(71,23) Stel alsi1(69,12) Vale offi1(73,6)

Items in POSITIVE group 23 (N= 99) i.e. g**roup *0111**
SJ71R SJ71S SJ71V SJ71W SJ71X SJ72H SJ72R SJ75V SJ80G SJ80J SJ80R SJ80S SJ80X SJ81B SJ81F SJ81N SJ82C SJ82G SJ82Q SJ82S SJ90B SJ90C SJ90D SJ90H SJ90L SJ90Y SJ91A SJ91B SJ91E SJ92N SK00Q SK00R SK00S SK00T SK00U SK00V SK00W SK00X SK00Y SK01M SK01P SK01U SK01Z SK02Q SK02R SK10A SK10B SK10C SK10D SK10F SK10H SK10K SK10M SK10N SK10Q SK10T SK10V SK10Z SK11F SK11H SK11M SK11V SK12A SK12S SK20D SK20E SK20I SK20P SK21B SK21D SK21F SK21G SK21Q SK22D SK22H SK22K SO78Z SO88L SO88N SO88P SO88Q SO88R SO88T SO88V SO89E SO89G SO89H SO89J SO89P SO89Z SO98H SP08C SP08G SP08H SP08I SP08P SP09N SP09U SP19Z

BORDERLINE positives (N= 25)
SJ80S SJ80X SJ81N SJ82Q SJ82S SJ90B SK01M SK01Z SK02R SK10Q SK10V SK10Z SK11H SK11M SK11V SK12S SK20I SK21D SK21F SK22H SK22K SO78Z SO89E SO89P SO89Z

MISCLASSIFIED positives (N= 6) SJ90C SJ91B SK00W SO89J SP09N SP09U

POSITIVE PREFERENTIALS

NON-PREFERENTIALS (***deleted to save space***)

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DIVISION 12 (N= 240) I.E. GROUP *100
Eigenvalue 0.034 at iteration 6
INDICATORS,together with their SIGN
Lami gSSm1(+) Stac offi1(+) Succ prat1(+) Anem nemo1(+) Brac sylv1(+) Card amar1(+) Lych flos1(+)
Maximum indicator score for negative group 3 Minimum indicator score for positive group 4

Items in NEGATIVE group 24 (N= 136) i.e. **group *1000**
SJ63R SJ63W SJ70V SJ71Q SJ71Y SJ72I SJ72L SJ72M SJ72P SJ72S SJ72U SJ72Y SJ72Z SJ73C SJ73D SJ73E SJ73P SJ73Q SJ73R SJ73W SJ74K SJ74L SJ74U SJ74V SJ75K SJ80A SJ80E SJ80F SJ80P SJ80T SJ81C SJ81D SJ81E SJ81H SJ81I SJ81J SJ81K SJ81M SJ81T SJ81U SJ81V SJ81Y SJ82B SJ82D SJ82H SJ82I SJ82J SJ82L SJ82M SJ82N SJ82U SJ82Z SJ83A SJ83B SJ83C SJ83D SJ83E SJ83G SJ83H SJ83I SJ83J SJ83K SJ83M SJ83N SJ83P SJ83Q SJ83R SJ83V SJ83W SJ84F SJ84M SJ84R SJ85T SJ91K SJ91M SJ91N SJ91T SJ92E SJ92M SJ92P SJ92S SJ92U SJ92V SJ92W

SJ92Z SJ93E SJ93K SJ93M SJ93U SJ93W SJ93Z SJ94Q SJ94X SJ95P SJ96C SK00Z

SK01Q SK01W SK02C SK02E SK02H SK02I SK02J SK02L SK02M SK02S SK02Y SK03A
SK03B SK03E SK03G SK03H SK04C SK11E SK12C SK12D SK12I SK12L SK12M SK12R
SK12W SK12Y SK13C SK13E SK14B SK20J SK20N SK20U SK21C SO78K SO88C SO88G
SO89A SP09Z SP19P SP19U

BORDERLINE negatives (N= 15) SJ82H SJ82J SJ83I SJ92P SJ92U SJ92W SJ93Z SK02M SK03H SK12L SK12M SK12Y SK14B SO78K SO88C

MISCLASSIFIED negatives (N= 9) SJ63W SJ75K SJ83A SJ83B SJ83D SJ84R SJ91M SJ92Z SK12I

Items in POSITIVE group 25 (N= 104) i.e. **group *1001**
SJ63X SJ72Q SJ72X SJ73B SJ73J SJ73S SJ73T SJ73V SJ73X SJ73Y SJ74M SJ74N
SJ74P SJ74Q SJ74R SJ74S SJ74T SJ74W SJ74X SJ75Q SJ75W SJ80N SJ81A SJ81G
SJ81L SJ81P SJ81Q SJ82E SJ82K SJ83S SJ83U SJ83Z SJ84A SJ84B SJ84C SJ84G
SJ84H SJ84L SJ85B SJ92J SJ93C SJ93F SJ93G SJ93H SJ93I SJ93L SJ93Q SJ93R
SJ93S SJ93T SJ93V SJ93X SJ93Y SK01R SK01S SK01X SK02G SK02N SK02P SK02T
SK02U SK02V SK02Z SK03C SK03D SK03F SK03I SK03J SK03K SK03L SK03M SK03N
SK03P SK03Q SK03R SK03S SK03T SK03U SK03V SK03Y SK03Z SK04D SK04M SK04Q
SK04V SK12B SK12E SK12G SK12J SK12N SK12T SK12U SK12X SK13F SK14A SK14G
SK14M SK14N SK14P SK15F SK22C SO77U SO78W SO88B

BORDERLINE positives (N= 24)
SJ63X SJ73J SJ73S SJ73T SJ73V SJ73X SJ74Q SJ74R SJ75W SJ82K SJ93T SJ93Y
SK01R SK01X SK02N SK02T SK03K SK03L SK03Q SK03Y SK04M SK04Q SK12B SK12N

MISCLASSIFIED positives (N= 6) SJ81A SJ81G SJ93I SK03D SK03J SO78W

NEGATIVE PREFERENTIALS Fuma offi1(44,16)

POSITIVE PREFERENTIALS
Vero mont1(53,82) Achi ptar1(10,27) Agri eupa1(16,34) Alch fili1(8,26) Anem nemo1(47,84) Bide cern1(17,31) Brac sylv1(52,85) Briz medi1(5,26) Card amar1(22,70) Care flac1(17,51) Care nigr1(26,51) Care pani1(24,61) Care ripa1(11,26) Care sylv1(22,56) Chry oppo1(45,78) Dact fuch1(9,23) Dryo affi1(16,42) Elym cani1(30,58) Equi fluv1(22,40) Equi palu1(34,60) Equi telm1(12,31) Fest ovin1(27,43) Fest prat1(30,50) Gali odor1(11,40) Gera prat1(14,22) Hype tetr1(43,69) Junc acut1(38,71) Lami gSSm1(24,77) Leon hisp1(10,24) Lych flos1(27,71) Lysi nemo1(31,63) Meco camb1(17,26) Meli unif1(17,49) Mili effu1(28,61) Myce mura1(14,28) Peta hybr1(26,50) Pimp majo1(16,48) Pimp saxi1(12,28) Poly acul1(11,22) Pote angl1(13,21) Prim veri1(19,37) Puli dyse1(7,23) Ribe nigr1(15,28) Sang offi1(28,55) Sene aqua1(18,48) Stac offi1(17,63) Succ prat1(24,68) Trif medi1(37,58)

NON-PREFERENTIALS
Verb thap1(20,23) Vero agre1(44,40) Vero arve1(106,75) Vero becc1(110,101) Vero cham1(133,102) Vero fili1(26,29) Vero hede1(89,67) Vero pers1(123,80) Vero serp1(91,86) Vibu opul1(89,87) Vici crac1(118,100) Vici hirs1(77,58) Vici sepi1(118,101) Vici snig1(33,36) Vici sseg1(66,41) Viol arve1(87,50) Viol odor1(19,28) Viol rivi1(96,96) Acer camp1(121,96) Acer plat1(41,34) Acer pseu1(133,104) Achi mill1(134,104) Adox mosc1(52,74) Aego poda1(120,92) Aesc hipp1(98,79) Aeth cyna1(55,40) Agro cani1(27,28) Agro capi1(127,101) Agro giga1(55,56) Agro stol1(116,103) Ajug rept1(59,86) Alis plan1(56,60) Alli peti1(133,104) Alli ursi1(50,68) Alnu glut1(126,104) Alop geni1(97,93) Alop prat1(128,102) Anag arve1(71,38) Ange sylv1(108,102) Anis ster1(123,92) Anth odor1(116,103) Anth sylv1(136,104) Apiu nodi1(92,78) Arab thal1(87,63) Arct minu1(124,100) Armo rust1(45,41) Arrh elat1(131,104) Arte vulg1(117,96) Arum macu1(103,99) Athy fili1(70,87) Atri patu1(115,93) Atri pros1(89,74) Aven fatu1(48,47) Ball nigr1(46,21) Barb vulg1(38,34) Bell pere1(134,104) Betu pend1(110,98) Betu pube1(74,67) Bras napu1(62,53) Brom hord1(109,93) Brom ramo1(61,83) Budd davi1(19,24) Call spec1(79,81) Calt palu1(56,75) Caly sepi1(107,99) Caly silv1(76,64) Camp rotu1(45,51) Caps burs1(131,99) Card flex1(121,104) Card hirs1(110,86) Card prat1(102,97) Care amis1(53,49) Care hirt1(71,80) Care otru1(25,24) Care oval1(38,32) Care pata1(19,27) Care pend1(28,32) Care remo1(60,69) Carp betu1(31,35) Cast sati1(78,72) Cent eryt1(21,21) Cent nigr1(126,104) Cera clav1(29,24) Cera font1(134,104) Cera glom1(112,96) Chae temu1(71,57) Cham angu1(131,104) Chel maju1(60,46) Chen albu1(121,92) Chen rubr1(41,40) Circ lute1(76,94) Cirs arve1(136,104) Cirs palu1(96,102) Cirs vulg1(134,104) Clay sibi1(30,24) Coch dani1(37,26) Coni macu1(32,24) Cono maju1(101,101) Conv arve1(46,30) Corn sang1(42,54) Cory avel1(133,104) Crat mono1(135,104) Crep capi1(86,75) Cruc laev1(42,43) Cymb mura1(17,22) Cyno cris1(105,101) Cyti scop1(70,53) Dact glom1(136,104) Desc cesp1(109,104) Desc flex1(54,48) Digi purp1(129,103) Dips full1(39,35) Dryo dila1(123,103) Dryo fili1(131,104) Eleo palu1(31,34) Elyt repe1(120,101) Epil cili1(109,90) Epil hirs1(132,104) Epil obsc1(76,78) Epil palu1(31,41) Epil parv1(66,61) Epil xert1(111,96)

Equi arve1(128,104) Euph heli1(76,54) Euph pepl1(90,64) Fagu sylv1(115,92) Fall conv1(63,42) Fall japo1(51,38) Fest arun1(57,56) Fest giga1(71,91) Fest rubr1(125,102) Fili ulma1(124,104) Frag vesc1(31,42) Frax exce1(136,104) Gala niva1(32,27) Gale tagg1(112,100) Gali apar1(136,104) Gali palu1(94,91) Gali saxa1(46,47) Gali veru1(48,36) Gera diss1(110,86) Gera luci1(45,37) Gera moll1(88,59) Gera robe1(134,104) Geum urba1(127,103) Glec hede1(122,103) Glyc decl1(35,38) Glyc flui1(89,93) Glyc maxi1(44,29) Glyc nota1(56,60) Gnap ulig1(79,67) Hede heli1(135,104) Hera spho1(136,104) Hier saba1(22,28) Holc lana1(135,104) Holc moll1(127,102) Hord muri1(29,24) Humu lupu1(37,42) Hyac non-1(121,100) Hyac xmas1(41,28) Hype perf1(51,42) Hypo radi1(124,102) Ilex aqui1(134,104) Impa glan1(59,57) Iris pseu1(75,74) Junc arti1(70,81) Junc bagg1(99,93) Junc cong1(60,68) Junc effu1(132,103) Junc infl1(94,97) Lact serr1(35,28) Lami albu1(132,102) Lami gSSa1(31,35) Lami purp1(116,95) Laps comm1(132,104) Lari deci1(68,71) Lari xmar1(30,31) Lath prat1(123,103) Lemn mino1(88,81) Leon autu1(115,101) Leuc vulg1(75,73) Ligu oval1(31,25) Ligu vulg1(51,48) Loli mult1(64,52) Loli pere1(135,104) Loni peri1(127,103) Lotu corn1(110,103) Lotu pedu1(85,92) Luna annu1(41,49) Luzu camp1(98,94) Lyco euro1(60,44) Lysi numm1(30,37) Lysi punc1(23,23) Malu pumi1(79,69) Malv mosc1(23,24) Malv sylv1(53,34) Matr disc1(131,102) Matr recu1(110,86) Medi lupu1(90,74) Ment aqua1(55,71) Merc pere1(117,103) Moeh trin1(74,82) Myos arve1(120,87) Myos laxa1(61,60) Myos scor1(41,59) Myos sylv1(85,78) Nuph lute1(18,24) Oxal acet1(75,91) Papa dubi1(50,30) Papa rhoe1(63,27) Papa somn1(36,40) Pent semp1(46,40) Pers amph1(74,65) Pers bist1(22,28) Pers hydr1(69,66) Pers lapa1(41,40) Pers macu1(123,100) Phal arun1(101,94) Phle bert1(31,30) Phle prat1(127,103) Phra aust1(23,21) Phyl scol1(35,51) Pice abie1(37,43) Pilo aura1(33,23) Pilo offi1(58,68) Pinu sylv1(86,77) Plan lanc1(134,104) Plan majo1(135,104) Poa annu1(134,103) Poa nemo1(33,32) Poa prat1(108,93) Poa triv1(133,102) Pold vule1(27,26) Poly aren1(74,71) Poly avic1(127,102) Popu alba1(15,22) Popu nIta1(25,34) Popu trem1(31,34) Popu xcan1(48,45) Pota nata1(33,47) Pote anse1(95,90) Pote erec1(64,83) Pote rept1(115,95) Pote ster1(56,84) Prim vulg1(62,77) Prun aviu1(98,84) Prun dome1(101,85) Prun laur1(36,29) Prun padu1(25,29) Prun spin1(129,104) Prun vulg1(105,103) Pter aqui1(119,95) Quer cerr1(28,31) Quer petr1(41,43) Quer robu1(135,104) Quer xros1(22,25) Ranu acri1(128,104) Ranu bulb1(72,74) Ranu fica1(114,100) Ranu flam1(33,50) Ranu fSSb1(53,62) Ranu repe1(136,104) Ranu scel1(81,68) Raph raph1(30,19) Rese lula1(29,26) Rhod pont1(71,60) Ribe rubr1(44,67) Ribe uva-1(83,78) Rori nagg1(56,57) Rori palu1(40,28) Rosa arve1(118,101) Rosa cagg1(131,102) Rubu frut1(136,104) Rubu idae1(100,85) Rume acet1(122,104) Rume alla1(96,73) Rume cong1(64,69) Rume cris1(117,99) Rume hydr1(19,29) Rume obtu1(135,104) Rume sang1(111,101) Sagi proc1(91,84) Sali alba1(35,39) Sali capr1(119,100) Sali cine1(121,96) Sali frag1(119,103) Sali vimi1(44,40) Samb nigr1(136,104) Scro auri1(37,47) Scro nodo1(94,85) Scut gale1(22,23) Sene jaco1(125,103) Sene visc1(23,22) Sene vulg1(131,101) Sile dioi1(134,103) Sile lati1(41,28) Sina arve1(59,54) Sisy offi1(116,84) Sola dulc1(128,98) Sola nigr1(52,38) Sonc arve1(95,75) Sonc aspe1(131,101) Sonc oler1(124,100) Sorb aucu1(105,91) Spar erec1(61,76) Sper arve1(30,20) Stac palu1(32,25) Stac sylv1(132,104) Stel alsi1(79,88) Stel gram1(98,94) Stel holo1(123,102) Stel medi1(135,104) Stel negl1(21,27) Symp albu1(84,81) Symp xupl1(69,54) Syri vulg1(53,31) Tamu comm1(93,86) Tana part1(56,53) Tana vulg1(31,20) Tara offi1(134,104) Taxu bacc1(78,66) Teuc scor1(63,44) Tili xeur1(89,66) Tori japo1(63,78) Trag prat1(47,50) Trif camp1(22,23) Trif dubi1(112,91) Trif hybr1(29,25) Trif prat1(128,104) Trif repe1(134,104) Trip inod1(118,95) Tris flav1(53,52) Trit aest1(20,24) Tuss farf1(98,99) Typh lati1(87,72) Ulex euro1(100,74) Ulex gall1(28,28) Ulmu glab1(120,102) Ulmu proc1(57,39) Urti dioi1(136,104) Urti uren1(46,24) Vale offi1(66,79)

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DIVISION 13 (N= 80) I.E. GROUP *101
Eigenvalue 0.053 at iteration 5
INDICATORS,together with their SIGN
Pote ster1(-) Glec hede1(-) Viol rivi1(-) Dryo affi1(-) Cera clav1(-) Lysi nemo1(-) Vero offi1(-)
Maximum indicator score for negative group -4 Minimum indicator score for positive group -3

Items in NEGATIVE group 26 (N= 44) i.e. **group *1010**
SJ73G SJ73H SJ73I SJ73K SJ73L SJ73M SJ73N SJ73U SJ73Z SJ74Y SJ74Z SJ82A
SJ83Y SJ84E SJ84K SJ85X SJ85Z SJ91U SJ93D SJ94V SJ94W SJ94Z SJ95G SJ95M
SJ95N SJ95Q SJ95T SJ95U SJ95X SJ95Y SJ96F SJ96G SJ96L SK01D SK01L SK04A
SK04F SK04G SK04H SK04J SK04K SK04L SK04R SO77P

BORDERLINE negatives (N= 4) SJ84E SJ95G SJ95M SJ95Y

Items in POSITIVE group 27 (N= 36) i.e. **group *1011**
SJ84V SJ84Z SJ85A SJ85G SJ85H SJ85N SJ85R SJ85S SJ85U SJ85W SJ85Y SJ91S
SJ91X SJ93J SJ93N SJ93P SJ94A SJ94D SJ94E SJ94F SJ94H SJ94I SJ94J SJ94L
SJ94M SJ94N SJ94P SJ94T SJ95A SJ95B SJ95E SJ95F SK01C SK01I SK01K SK04B

BORDERLINE positives (N= 6) SJ91S SJ91X SJ93J SJ94T SJ95F SK01I

MISCLASSIFIED positives (N= 1) SJ85G

NEGATIVE PREFERENTIALS
Vero mont1(32,10) Vero offi1(27,3) Viol palu1(14,2) Viol rivi1(43,13) Adox mosc1(24,6) Agro cani1(26,6) Aira prae1(14,5) Ajug rept1(35,11) Anag arve1(14,3) Apha aust1(15,3) Aren serp1(17,6) Arum macu1(18,5) Aspl ruta1(13,4) Aspl tric1(10,2) Brac sylv1(18,4) Briz medi1(12,3) Brom ramo1(17,5) Care amis1(18,5) Care cary1(13,0) Care pata1(23,2) Care remo1(32,11) Care sylv1(24,3) Cent eryt1(29,11) Cera clav1(37,8) Chae temu1(13,1) Chel maju1(31,10) Circ lute1(33,12) Conv arve1(13,5) Cruc laev1(14,0) Dact prae1(15,6) Dryo affi1(31,7) Dryo cart1(13,5) Fest prat1(21,7) Gala niva1(11,2) Gali odor1(19,6) Gali veru1(10,1) Gera prat1(12,2) Glec hede1(40,11) Humu lupu1(10,4) Hydr vulg1(9,3) Hype pulc1(14,1) Hype tetr1(26,7) Isol seta1(9,2) Knau arve1(18,4) Lami gSSm1(20,3) Lari deci1(35,14) Leon hisp1(18,3) Linu cath1(18,5) Luzu pilo1(21,1) Luzu sylv1(25,4) Lych flos1(32,11) Lysi nemo1(36,9) Lysi numm1(20,4) Malv mosc1(16,5) Meli unif1(9,1) Mili effu1(17,2) Mont font1(13,3) Myce mura1(18,3) Papa rhoe1(11,2) Phra aust1(10,4) Pice abie1(20,3) Pice sitc1(11,0) Pimp majo1(9,1) Pold vule1(17,3) Poly serp1(14,1) Popu nIta1(13,4) Pote angl1(10,4) Pote ster1(36,3) Prim veri1(12,4) Prim vulg1(14,1) Pseu menz1(10,2) Quer cerr1(24,9) Quer rubr1(18,7) Ranu scel1(18,7) Ribe rubr1(23,6) Rume sang1(36,14) Sali auri1(14,2) Scir sylv1(14,2) Sene sylv1(10,3) Soli virg1(13,2) Spar emer1(9,2) Stac offi1(18,6) Tamu comm1(18,2) Taxu bacc1(33,13) Tili cord1(9,2) Trit aest1(12,4)

POSITIVE PREFERENTIALS
Vero fili1(8,17) Vulp myur1(3,10) Arte absi1(5,12) Bras rapa1(3,11) Budd davi1(9,18) Erop vern1(4,9) Gera xoxo1(5,10) Meli alti1(3,13) Ment spic1(8,14) Oeno glaz1(0,10) Pucc dist1(3,9) Rese lute1(4,8) Rosa rugo1(7,13) Sali pent1(7,15) Sali xsmi1(6,12) Sisy orie1(1,11) Soli giga1(4,11)

NON-PREFERENTIALS (***deleted to save space***)

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DIVISION 14 (N= 82) I.E. GROUP *110
Eigenvalue 0.065 at iteration 3
INDICATORS,together with their SIGN
Merc pere1(-) Pote ster1(-) Vero mont1(-) Adox mosc1(-) Sola dulc1(-)
Maximum indicator score for negative group -3 Minimum indicator score for positive group -2

Items in NEGATIVE group 28 (N= 36) i.e. **group *1100**
SJ86V SJ94S SJ94U SJ94Y SJ95C SJ95D SJ95H SJ95I SJ95J SJ95L SJ95R SJ95S
SJ95V SJ95W SJ95Z SJ96B SJ96K SJ96R SJ96S SJ96V SK04E SK04I SK04N SK04S
SK04T SK04U SK04W SK04X SK05A SK05C SK05P SK05Q SK05R SK05T SK14H SK15J

BORDERLINE negatives (N= 5) SJ95D SJ96R SK05P SK05R SK05T

MISCLASSIFIED negatives (N= 3) SJ94U SK04N SK05Q

Items in POSITIVE group 29 (N= 46) i.e**. group *1101**
SJ91Y SJ91Z SJ94R SJ95K SJ96A SJ96Q SJ96W SJ96X SK01E SK04P SK05B SK05D
SK05E SK05F SK05G SK05H SK05I SK05J SK05K SK05L SK05M SK05N SK05S SK05U
SK06A SK06B SK06C SK06D SK06F SK06G SK06H SK06I SK06J SK06K SK06L SK06M
SK06N SK06Q SK06R SK06S SK06T SK06V SK06W SK06X SK16A SK16B

BORDERLINE positives (N= 3) SJ94R SJ95K SK16A

MISCLASSIFIED positives (N= 3) SK05B SK05I SK06F

NEGATIVE PREFERENTIALS
Vero hede1(13,4) Vero mont1(28,8) Vibu opul1(33,18) Acer plat1(11,7) Adox mosc1(22,4) Aren serp1(12,4) Arum macu1(12,2) Brac sylv1(11,3) Bras napu1(12,6) Brom ramo1(13,3) Caly silv1(15,9) Camp lati1(8,1) Care remo1(21,7) Care sylv1(16,3) Carp betu1(8,4) Cast sati1(16,8) Cera clav1(21,9) Chel maju1(9,1) Chen albu1(24,15) Chen rubr1(8,4) Circ lute1(24,9) Corn sang1(9,3) Crep capi1(15,9) Cyti scop1(21,13) Dips full1(11,4) Epil parv1(19,12) Epil rose1(8,3) Epip hell1(9,0) Fest giga1(30,13) Frag vesc1(17,7) Gali odor1(15,1) Gera diss1(9,3) Gera moll1(9,4) Glyc nota1(22,12) Gnap ulig1(21,8) Hype perf1(9,1) Impa glan1(21,10) Knau arve1(13,8) Lami gSSa1(11,7) Lami gSSm1(10,0) Ligu oval1(9,3) Luzu pilo1(18,5) Lyco euro1(9,0) Meli unif1(8,0) Ment xpip1(8,4) Merc pere1(34,13) Mili effu1(8,0) Moeh trin1(14,5) Myce mura1(14,4) Papa dubi1(9,2) Pers amph1(12,5) Pers hydr1(20,12) Phyl scol1(18,7) Pimp saxi1(14,6) Plat chlo1(9,3) Poa nemo1(9,1) Popu alba1(11,1) Popu xcan1(9,4) Pote angl1(9,3) Pote anse1(24,15) Pote palu1(9,5) Pote rept1(25,14) Pote ster1(33,14) Prim veri1(10,5) Prun dome1(23,13) Rhod pont1(27,13) Ribe rubr1(20,9) Rume sang1(27,9) Sali frag1(30,15) Scir sylv1(8,3) Sola dulc1(26,8) Sorb aria1(9,4) Stac offi1(18,9) Stac palu1(15,5) Syri vulg1(10,4) Taxu bacc1(19,4)

POSITIVE PREFERENTIALS
Viol lute1(2,12) Agro vine1(5,19) Alch glab1(12,33) Care bine1(6,21) Care echi1(8,24) Crep palu1(7,19) Empe nigr1(4,21) Eric tetr1(5,22) Erio angu1(6,26) Erio vagi1(3,23) Myos secu1(10,31) Nart ossi1(2,13) Pice sitc1(3,14) Poly serp1(10,29) Pucc dist1(7,28) Ranu omio1(6,25) Rosa moll1(4,12) Rume alpi1(6,17) Rume xpra1(1,11) Sali xmul1(9,29) Trig palu1(5,19) Vacc viti1(10,27)

NON-PREFERENTIALS (***deleted to save space***)

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DIVISION 15 (N= 21) I.E. GROUP *111
Eigenvalue 0.104 at iteration 4
INDICATORS,together with their SIGN
Epil palu1(-) Gale tagg1(-) Gali palu1(-) Junc arti1(-) Ranu flam1(-) Achi ptar1(-)
Maximum indicator score for negative group -5 Minimum indicator score for positive group -4

Items in NEGATIVE group 30 (N= 6) i.e. group *1110 SK04Y SK14C SK14D SK14E SK14I SK14J

Items in POSITIVE group 31 (N= 15) i.e. **group *1111**
SK04Z SK05V SK05W SK05X SK05Y SK05Z SK15A SK15B SK15C SK15D SK15E SK15G
SK15H SK15I SK15K

BORDERLINE positives (N= 1) SK04Z

NEGATIVE PREFERENTIALS
Vero fili1(3,3) Vero mont1(5,6) Vici hirs1(2,2) Vici sseg1(3,2) Viol palu1(2,0) Achi ptar1(5,2) Agro cani1(2,0) Alis plan1(2,1) Arab cauc1(2,1) Armo rust1(3,1) Arte vulg1(5,4) Aspl adia1(2,1) Aven sati1(2,0) Betu pend1(5,5) Blec spic1(4,0) Botr luna1(2,1) Call vulg1(4,2) Card amar1(4,2) Care echi1(2,0) Care hirt1(4,2) Care host1(2,0) Care nigr1(4,2) Care oval1(4,3) Care pani1(4,5) Care pend1(2,1) Care remo1(4,0) Care spic1(2,0) Care sylv1(4,5) Care vSSo1(3,0) Cent eryt1(2,0) Cent mont1(2,2) Cete offi1(2,2) Chen albu1(4,5) Circ lute1(6,6) Cirs acau1(3,3) Coel viri1(2,1) Coto hori1(2,0) Cupr macr1(2,0) Cyti scop1(2,1) Dips full1(3,2) Eleo palu1(3,0) Epil palu1(5,1) Equi fluv1(3,3) Equi palu1(3,2) Equi sylv1(2,0) Eric tetr1(3,0) Erio angu1(2,0) Gale tagg1(6,4) Gali palu1(6,4) Gent amar1(3,3) Glyc flui1(6,5) Hyac xmas1(3,2) Hype macu1(2,1) Hype pulc1(2,2) Hype tetr1(4,1) Junc acut1(4,5) Junc arti1(6,4) Junc bagg1(5,6) Junc cong1(4,5) Junc infl1(5,6) Junc squa1(2,0) Lemn tris1(2,0) List ovat1(5,3) Loni peri1(6,7) Luna annu1(4,1) Luzu mult1(2,2) Lych flos1(5,4) Lysi numm1(2,0) Malu pumi1(2,2) Matr recu1(4,1) Ment aqua1(5,5) Ment spic1(2,1) Mili effu1(4,1) Moli caer1(3,0) Narc pseu1(2,0) Nard stri1(4,1) Ophi vulg1(4,2) Papa dubi1(2,0) Parn palu1(2,1) Pedi sylv1(4,3) Pers hydr1(2,1) Pice abie1(2,0) Plat chlo1(3,3) Poa humi1(2,1) Poly serp1(4,5) Popu trem1(3,1) Pota nata1(4,2) Pote rept1(5,6) Prun dome1(2,2) Pter aqui1(4,3) Pucc dist1(3,3) Puli dyse1(2,0) Ranu aqua1(2,0) Ranu flam1(6,4) Ranu hede1(2,2) Ranu ling1(2,0) Rese lula1(2,0) Ribe rubr1(4,5) Rume alla1(5,4) Sali auri1(2,1) Sali repe1(2,0) Seca cere1(3,0) Sene aqua1(5,3) Sene squa1(2,2) Serr tinc1(2,2) Sonc arve1(6,5) Spar erec1(3,2) Succ prat1(6,7) Symp offi1(2,0) Tric cesp1(2,0) Trif hybr1(3,1) Trip inod1(5,3) Trit aest1(3,1) Typh lati1(3,3) Ulex gall1(5,6) Ulmu proc1(2,0) Vacc myrt1(4,0) Vale dioi1(4,0)

POSITIVE PREFERENTIALS
Vero hede1(2,13) Vero offi1(2,10) Acer plat1(0,5) Anth vuln1(0,7) Arab hirs1(2,13) Arab thal1(2,11) Aspl tric1(2,13) Chel maju1(1,5) Cirs hete1(0,5) Clay sibi1(0,7) Clin acin1(0,4) Coto inte1(0,4) Drab mura1(1,5) Fest xper1(1,5) Gala niva1(1,7) Gera luci1(2,15) Geum xint1(1,5) Hier vagu1(0,4) Hype hirs1(2,13) Impa glan1(1,7) Lami macu1(1,6) Ligu oval1(0,4) Luzu pilo1(0,4) Malv sylv1(0,4) Meco camb1(0,10) Meli unif1(1,7) Orig vulg1(0,10) Pers bist1(1,6) Phyl scol1(1,9) Poa nemo1(1,6) Pole caer1(0,4) Pote tabe1(0,7) Rham cath1(0,7) Ribe alpi1(2,11) Rosa moll1(0,6) Sagi proc1(2,10) Sali vimi1(1,6) Saxi hypn1(0,6) Sedu tele1(0,7) Sile nuta1(0,4) Taxu bacc1(1,6)

NON-PREFERENTIALS (***deleted to save space***)

End of level 4

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APPENDIX D - OUTLINE OF STAFFORDSHIRE

D.1 Staffordshire Moorlands and Leek

The area around Leek is one of varied geology, with Millstone Grit, Sherwood Sandstone and Carboniferous Limestone. The topography is frequently steep, the predominant agriculture is sheep or beef farming with relatively low inputs.

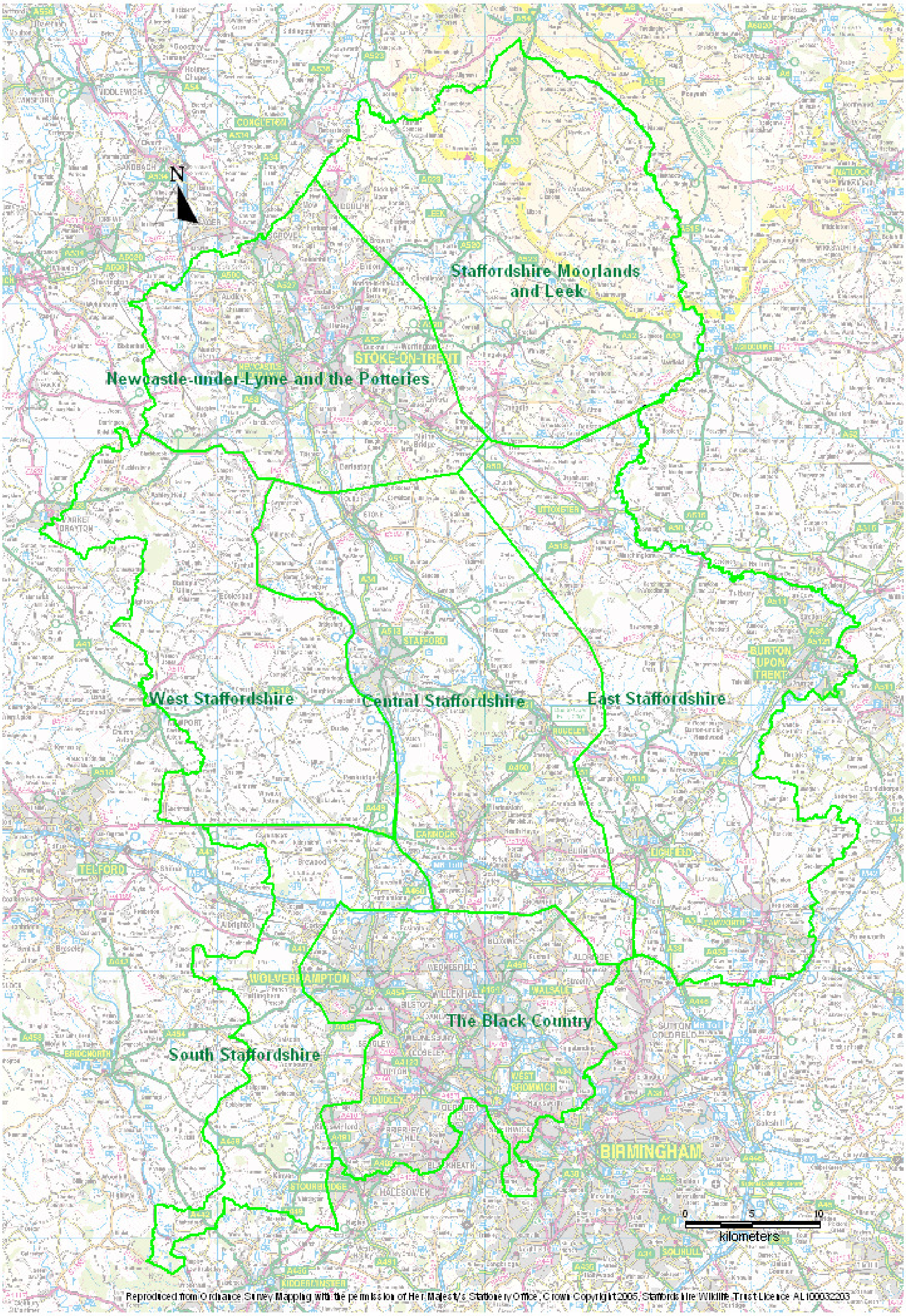
The Staffordshire part of the Peak District has three major Sites of Special Scientific Interest (SSSIs). The Leek Moors comprises heather moorland, which also has small areas of blanket bog at its southernmost location in England, with *Eriophorum vaginatum*. *Rubus chamaemorus* occurs here at the south-eastern limit of its British range (English Nature, 1988). The Hamps and Manifold Valleys and the Dove Valley are situated on the limestone to the east and are designated for a combination of limestone karst geology, unimproved grassland and woodlands. Species of note include both *Tilia cordata* and *Tilia platyphyllos*, *Daphne mezereum, Ribes alpinum, Galium sterneri, Silene nutans* and *Hornungia petraea* (English Nature, 1990).

To the south of the Peak District is an area known as the Weaver Hills, with a complex geology that can change from one field to the next. It is particularly noted for its species-rich grasslands, many of which are in SSSIs. Other habitats, such as heathland, are also important as part of the overall matrix. Limestone quarries operate around Cauldon.

Leek has an industrial history of silk production, while Cheadle produced cottons. The Cauldon canal is still operational, being fed from Rudyard Lake reservoir, which receives its water from the River Dane to the north. The River Dane itself is in the Mersey catchment, while the Cauldon canal and the River Churnet flow into the Trent. Sand and gravel are quarried around Cheadle.

The Churnet Valley is a steep-sided, extensively wooded valley, which runs southeast from Cheddleton to Alton, with soils varying from dry acidic ones to wet base-rich ones in the valley bottoms, and differing slopes and aspects along the main valley and tributaries. Most of the valley is designated as a SSSI for its wide range of woodland types and for unimproved grasslands on its slopes.

Figure D1 - Areas of Staffordshire described in text



D.2 Newcastle-under-Lyme and the Potteries

The area of Stoke on Trent is famous for its pottery industry. One or two potteries are still operational, although many have closed down. Clay pits are still apparent on pockets of Etruria Marl. The Silverdale area to the west of Newcastle, and Hem Heath in the south, were known for their deep coal mines. Opencast mining occurred around Silverdale and to the northwest of the conurbation.

In the late 1970s, Teagle put forward a view that the piecemeal development of the Black Country conurbation meant that the area had *"...kept a remarkable array of wild woods, rock precipices, marshy pools and grazing land enmeshed amongst its towns..."* (Teagle, 1978, p.8). This high concentration of habitats has not apparently been subject to the agricultural improvement of surrounding areas. This can also be said to be true of the Potteries area, with its six towns having expanded but also leaving considerable open areas among the urban sprawl.

The area south and west of the conurbation is an agricultural landscape, mainly agriculturally improved and managed as arable land, but in places retaining relatively small fields. The area is generally well wooded, although most ancient woodland sites have been planted with conifers. Most of the conifer woods are on acidic soils and many of these are of heathland origin, for example Maer Hills. The area also contains several Meres and Mosses, described below (D.4).

D.3 Western Staffordshire

Western Staffordshire is predominantly arable land with large fields, although in some places there is a smaller field pattern, with hedges and mature hedgerow trees, usually oak or ash. Two sites, Allimore Green Common, near Haughton and Mottey Meadows at Wheaton Aston are outstandingly diverse grasslands.

The Shropshire Union Canal is an important feature, occupying the watershed between the Severn catchment to the west, and the Trent catchment, which forms the majority of the County. There are relatively few large villages, but many hamlets; the area is more populated around Wolverhampton in Codsall and Penkridge.

Parkland estates are important features of Western Staffordshire, although the open areas within the parks are usually improved, rather than traditional pasture or heathland. Most of the parkland at Aqualate near Newport is designated as an SSSI because of Aqualate Mere and areas of woodland and unimproved grassland.

D.4 Meres and Mosses

There are a number of Meres and Mosses scattered through the western side of the county, from the northern point at Betley Mere, down to Aqualate Mere, near Newport, Shropshire. They form part of the series of Meres and Mosses of glacial origin in the Cheshire – Shropshire plain. Nearly all the sites are notified as Sites of Special Scientific Interest, although two rather degraded sites are also known. Of the SSSI sites, only Aqualate has extensive surrounding habitats, although Loynton Moss near Woodseaves features wetland creation on surrounding land, to protect its hydrology.

The remainder of the Meres and Mosses are isolated 'islands' in the surrounding agricultural land, although they all have typical vegetation, such as reedswamp, carr woodland, fen pasture or schwingmoor dominated by *Sphagnum* species. Chartley Moss is an outlier, situated eleven kilometres northeast of Stafford, and is thought to have been formed by the *"...partial solution and collapse of underlying salt-bearing strata, and is an exceptionally uncommon phenomenon, observed only at Chartley Moss and Wybunbury Moss in Cheshire."*. Chartley Moss features the largest schwingmoor in Britain and is of European importance for the study of mire ecology. (English Nature, 1987)

D.5 Central Staffordshire

This part of the County is characterised by the broad valley of the River Trent, and its tributaries, including the Sow, which flows east from Stafford. Around Stafford there was a history of salt extraction from subterranean deposits. Doxey and Tillington Marshes SSSI includes a series of subsidence pools, which resulted from this activity in the mid 20th Century. The saline influence is still found in Pasturefields Saltmarsh SSSI, which has *Glaux maritima* and *Triglochin maritimum* (SJ991249) and at Astonfields Balancing Reservoir in Stafford with populations of *Cotula coronopifolia*, *Spergularia marina* and *Puccinellia distans* subspecies *distans*.

The highest ground in central Staffordshire is the Cannock Chase plateau, at 175 – 200 metres. This area of about fifty square kilometres between Stafford, Cannock and Rugeley is in largely public ownership, with heathland and coniferous forestry plantations. Central Staffordshire also features several large parkland estates, such as Shugborough and Weston Park, the underlying habitat is usually either arable or improved grassland.

D.6 East Staffordshire

The Rivers Blithe, Tame and Mease join the Trent at Kings Bromley and Alrewas to the south of Burton-upon-Trent and the landscape becomes dominated by water as the gravel deposits have been exploited, leaving many pools and lakes. Most of these have been restored for recreation and lack marginal vegetation. A few sites, including Croxall (SK189144) and Middleton Lakes (SK204994) are nature reserves. The National Memorial Arboretum near Alrewas (SK185145) is a former gravel site.

East Staffordshire also has a number of surviving parklands, but these are of poor botanical interest. Two elevated ridges of ground near Marchington and Needwood have extensive woodlands of ancient origin, often on base-rich clay soils with woodland plants that are rare or uncommon in the county, such as *Orchis mascula*, *Polystichum aculeatum* and *Polystichum setiferum*.

D.7 South Staffordshire

South Staffordshire is the narrow part of the rural county, which runs down the side of the Black Country to join up with Worcestershire near Kinver. It has a central spine of sandstone, from Highgate Common near Wombourne down to Kinver Edge, both sites are mainly heathland and are notified as Sites of Special Scientific Interest; further remnants of heathland may be found on golf courses in the area.

Penn Common is now a golf course, but still contains remnant wet grassland and mires communities, with *Cirsium dissectum*. Evidence for its existence (as a wet woodland) as far back as Anglo-Saxon England was given by Russell-O'Connor (2007), following research on the area around Penn Common, which showed that this area retains many of its ancient features. These features include small parcels of woodland at Park Hill with a typical ancient woodland ground flora.

A small area of the Wyre Forest is within the Staffordshire Vice County, and this area and similar clay soils to the west of Kinver support a wide range of woodland ground flora, shrub and tree species such as *Sorbus torminalis, Euonymus europaeus* and *Cornus sanguinea* which are uncommon in the sandstone dominated centre of the county.

D.8 The Black Country

Before the industrial revolution, the Black Country would have been a series of small villages. The presence of natural resources including coal, limestone and iron ore meant that the area rapidly became a centre of steel production, with associated foundries, factories, housing for workers and canals for transport. In fact, the area must have remained a mixture of urban and rural until relatively recently, with anecdotal evidence of cattle being driven along the A49 Wolverhampton to Bilston road as late as the 1920's (Kimber *pers comm.*). Walsall still has farmed land at Rushall and Barr Beacon, which is isolated from the wider countryside. Woodlands, particularly in the centre of the conurbation, are rare; Teagle considered that before the industrial revolution most of the area had been *"…agricultural land or heath. Most of the woodland had been cleared long before."* (Teagle, 1978, p.5)

As mentioned in D.2, Teagle's view was that the scattered development pattern of the Black Country had led to the retention of many habitat remnants among its towns. These habitat remnants have escaped agricultural improvement and are now often being managed for nature conservation, as in the Sandwell Valley, Sedgeley Beacon (limestone grassland) and at Barrow Hill (grasslands).

Most well-known nature conservation sites in the conurbation are those on post-industrial land where habitats have developed, often on artificial substrates such as spoil or rubble. These are frequently high in biodiversity, notably plants and invertebrates, which must be due in part to nearby habitat remnants providing a source of propagules. Many more species have arrived, from railways (species such as *Senecio squalidus*) and roads (Teagle mentioned *Matricaria discoidea*), and as garden escapes, for example *Solidago canadensis*.

APPENDIX E - SUGGESTED AMENDMENTS TO CURRENT LIST OF AXIOPHYTES

Species	Comments	Total tetrads
Acer campestre	Planted too frequently - suggest removal	704
Achillea ptarmica		199
Adoxa moschatellina		300
Agrimonia eupatoria		130
Agrostis canina		214
Agrostis vinealis		58
Aira caryophyllea		73
Aira praecox		110
Ajuga reptans	Accept*	402
Alchemilla filicaulis		101
Alchemilla glabra		72
Alchemilla xanthochlora		69
Alisma lanceolatum	High N – suggest removal	49
Allium ursinum	Accept*	318
Allium vineale	High N - suggest removal	32
Alopecurus aequalis	Retain	9
Anagallis tenella	Retain	9
Anchusa arvensis	Arable weed, Suggest removal	183
Anemone nemorosa		358
Angelica sylvestris	Reject - too frequent	656
Anthemis arvensis	Arable weed, Suggest removal	7
Anthemis cotula	Arable weed, Suggest removal	26
Anthriscus caucalis	Not confined to 1^0 habitats - Suggest removal	10
Anthyllis vulneraria		56
Aphanes arvensis	Reject - not confined to 1^0 habitats	176
Aphanes australis	Not confined to 1^0 habitats - Suggest removal	117
Apium inundatum	Retain	6
Arabis hirsuta		25
Arenaria serpyllifolia	Reject - not confined to 1^0 habitats	193
Arum maculatum	Reject - too frequent	525
Asplenium ruta-muraria	Reject – most records from built environment	210
Asplenium trichomanes	As above	112
Astragalus glycyphyllos	Retain	3
Athyrium filix-femina	Reject - too frequent	477
Barbarea vulgaris	Reject - not confined to 1^0 habitats	310
Berula erecta	Open water species, high N - Suggest removal	74
Bidens cernua	Open water species, high N - Suggest removal	107
Bidens tripartita		77
Blackstonia perfoliata	Not confined to 1^0 habitats - Suggest removal	8
Blechnum spicant		181
Botrychium lunaria	Retain	8
Brachypodium sylvaticum		376
Briza media		153

Bromopsis erecta		19
Bromopsis ramosa		371
Bromus racemosus	Retain	3
		89
Butomus umbellatus	Not confined to 1^0 habitats - suggest removal	
Calamagrostis canescens	Retain	13
Calamagrostis epigejos		15
Callitriche hamulata	Retain	
Callitriche obtusangula	Retain	
Callitriche platycarpa	Not confined to 1^0 habitats - Suggest removal	
Calluna vulgaris	Accept*	264
Caltha palustris	Accept**	443
Campanula latifolia		78
Campanula rotundifolia	Accept*	352
Campanula trachelium	Frequent garden escape - suggest removal	62
Cardamine amara		296
Cardamine impatiens	Retain	5
Carduus crispus	Reject – ruderal species	121
Carduus nutans	Reject – ruderal species	184
Carex acuta	Retain	12
Carex acutiformis	Accept*	318
Carex binervis		55
Carex caryophyllea		106
Carex curta	Retain	19
Carex disticha	Retain	50
Carex echinata		64
Carex flacca	Accept*	268
Carex hostiana	Retain	9
Carex laevigata	Retain	15
Carex muricata ssp. lamprocarpa	Retain	60
Carex nigra	Accept*	304
Carex otrubae	Not confined to 1^0 habitats - Suggest removal	246
Carex ovalis	Accept*	290
Carex pallescens	Retain	21
Carex panicea		269
Carex paniculata	Retain	143
Carex pilulifera		93
Carex pseudocyperus		83
Carex pulicaris	Retain	10
Carex remota	Accept*	356
Carex riparia		6
Carex rostrata	Retain	48
Carex spicata		79
Carex strigosa	Retain	24
Carex sylvatica		192
Carex viridula ssp. oedocarpa		96
Carlina vulgaris		20
Catabrosa aquatica	Not confined to 1^0 habitats - suggest removal	10
Centaurea scabiosa		42

Centaurium erythraea		260
Cerastium arvense	Not confined to 1^0 habitats - suggest removal	7
Cerastium diffusum	Not confined to 1^0 habitats - suggest removal	14
Cerastium semidecandrum		28
Ceratocapnos claviculata		166
Ceratophyllum demersum		54
Chaenorhinum minus	Reject – ruderal species	65
Chaerophyllum temulum	Possibly include – hedgerow species, even if quite disturbed	339
Chelidonium majus		412
Chrysanthemum segetum	Not confined to 1^0 habitats - suggest removal	47
Chrysosplenium alternifolium		37
Chrysosplenium oppositifolium	Accept*	344
Cicuta virosa	Retain	7
Circaea x intermedia	Not confined to 1^0 habitats - suggest removal	13
Cirsium acaule		7
Cirsium dissectum	Retain	16
Cirsium heterophyllum		15
Cirsium palustre	Reject - too frequent	622
Claytonia sibirica	Reject – neophyte	162
Clinopodium acinos	Not confined to 1^0 habitats - suggest removal	5
Clinopodium vulgare	Not confined to 1^0 habitats - suggest removal	21
Coeloglossum viride	Retain	5
Convallaria majalis	Frequent garden escape - suggest removal	28
Cornus sanguinea	Planted too frequently - suggest removal	380
Crepis capillaris	Reject - too frequent	654
Crepis paludosa		43
Cruciata laevipes	Accept	210
Cystopteris fragilis		23
Dactylorhiza fuchsii		210
Dactylorhiza maculata	Retain	23
Dactylorhiza praetermissa	Accept	123
Dactylorhiza purpurella	Retain	12
Dactylorhiza x grandis	Accept	39
Danthonia decumbens		109
Deschampsia cespitosa ssp. parviflora	Retain	7
Deschampsia flexuosa	Accept*	438
Dipsacus pilosus	Not confined to 1^0 habitats - suggest removal	21
Draba muralis		10
Drosera rotundifolia	Retain	12
Dryopteris affinis		162
Dryopteris carthusiana		72
Echium vulgare	Not confined to 1^0 habitats - suggest removal	24
Eleocharis palustris		232
Elymus caninus		283
Empetrum nigrum		35
Epilobium palustre		264
Epilobium roseum	Reject – ruderal species	168
Epipactis helleborine		65
Equisetum palustre		284

Equisetum sylvaticum		180
Equisetum telmateia	Not confined to 1^0 habitats - suggest removal	91
Equisetum x litorale	Not confined to 1^0 habitats - suggest removal	23
Erica cinerea		52
Erica tetralix		68
Eriophorum angustifolium		61
Eriophorum vaginatum		36
Erophila majuscula	Retain	2
Erophila verna		75
Euonymus europaeus	Retain	73
Eupatorium cannabinum		112
Euphorbia amygdaloides	Retain	31
Euphrasia anglica	Retain	
Euphrasia arctica	Retain	
Euphrasia confusa	Retain	
Euphrasia nemorosa	Retain	
Euphrasia species	Accept – segregates are not well recorded	119
Festuca gigantea	Retain	426
Festuca ovina	Accept*	389
Festuca pratensis		267
Filago minima	Not confined to 1^0 habitats - suggest removal	43
Filago vulgaris	Not confined to 1^0 habitats - suggest removal	45
Filipendula ulmaria	Reject - too frequent	715
Filipendula vulgaris	Retain	8
Fragaria vesca		229
Frangula alnus		83
Galeopsis speciosa	Arable weed Suggest removal	12
Galium odoratum		162
Galium palustre	Reject - too frequent	566
Galium saxatile	Accept*	398
Galium sterneri		21
Galium uliginosum	Retain	42
Galium verum	Reject - often found in urban lawns	373
Genista tinctoria	Retain	21
Gentianella amarella		9
Geranium columbinum		15
Geranium dissectum	Reject – ruderal species and too frequent	658
Geranium molle	Reject – ruderal species and too frequent	587
Geranium pratense		203
Geum rivale		117
Geum x intermedium		11
Glechoma hederacea	Reject - too frequent	664
Glyceria declinata		237
Glyceria notata	Accept*	319
Gymnadenia conopsea		7
Helianthemum nummularium		22
Helictotrichon pratense		15
Helictotrichon pubescens		45
Hieracium acuminatum	Accept	132
Hieracium sabaudum	Reject - not confined to 1^0 habitats	195

Hieracium vagum	Reject - not confined to 1^0 habitats	141
Hieracium vulgatum	Reject - not confined to 1^0 habitats	96
Hippuris vulgaris		29
Hordeum secalinum	Retain	43
Hornungia petraea	Retain	3
Hottonia palustris	Retain	6
Hydrocotyle vulgaris		60
Hymenophyllum wilsonii		
Hypericum hirsutum		57
Hypericum humifusum		80
Hypericum perforatum	Reject - too frequent	487
Hypericum pulchrum		102
Hypericum tetrapterum		307
Inula conyzae	Not confined to 1^0 habitats - suggest removal	10
Isolepis setacea		60
Jasione montana	Retain	8
Juncus acutiflorus	Accept*	367
Juncus bulbosus		98
Juncus gerardii	Retain	3
Juncus squarrosus		145
Juncus subnodulosus	Retain	8
Juncus tenuis	Reject – alien species	60
Knautia arvensis	Accept	192
Koeleria macrantha		31
Lamiastrum galeobdolon ssp. montanum		208
Lathraea squamaria		25
Lathyrus linifolius		134
Lathyrus nissolia	Retain	17
Lemna gibba	Open water species, high N, Suggest removal	22
Lemna trisulca	Retain	102
Leontodon hispidus		188
Leontodon saxatilis		53
Lepidium campestre	Arable weed, Suggest removal	18
Lepidium heterophyllum	Retain	6
Limosella aquatica	Not confined to 1^0 habitats Suggest removal	7
Linum catharticum		141
Listera ovata		29
Littorella uniflora	Retain	13
Lotus pedunculatus	Reject - too frequent	583
Luronium natans		8
Luzula multiflora		218
Luzula pilosa		87
Luzula sylvatica		129
Lychnis flos-cuculi	Accept*	327
Lysimachia nemorum		272
Lysimachia vulgaris		76
Lythrum portula	Not confined to 1^0 habitats Suggest removal	19
Lythrum salicaria	Retain	139
Malva moschata	Reject - not confined to 1^0 habitats	283
Malva neglecta	Reject - not confined to 1^0 habitats	112

Melampyrum pratense	Retain	20
Melica uniflora		153
Mentha arvensis	Not confined to 1^0 habitats - suggest removal	47
Mentha x gracilis	Not confined to 1^0 habitats - suggest removal	24
Mentha x verticillata	Not confined to 1^0 habitats - suggest removal	54
Menyanthes trifoliata	Retain	32
Mercurialis perennis	Reject - too frequent	613
Milium effusum		208
Moehringia trinervia	Accept*	384
Molinia caerulea		173
Monotropa hypopitys	Retain	6
Montia fontana		97
Myosotis discolor	Retain	86
Myosotis laxa	Reject - not confined to 1^0 habitats	350
Myosotis ramosissima		34
Myosotis scorpioides	Reject - not confined to 1^0 habitats	419
Myosotis secunda		73
Myosoton aquaticum	Retain	116
Myriophyllum spicatum		73
Myrrhis odorata	Reject - not confined to 1^0 habitats	167
Narcissus pseudonarcissus	Retain	26
Nardus stricta		205
Narthecium ossifragum	Retain	20
Nymphaea alba	Reject - not confined to 1^0 habitats	123
Odontites vernus		175
Oenanthe aquatica	Retain	20
Oenanthe crocata	Not confined to 1^0 habitats - suggest removal	156
Oenanthe fistulosa	Retain	13
Onobrychis viciifolia	Reject - not confined to 1^0 habitats	10
Ononis repens		44
Ophioglossum vulgatum		51
Orchis mascula		37
Oreopteris limbosperma		89
Origanum vulgare		56
Ornithopus perpusillus	Retain	50
Osmunda regalis	Garden escape - suggest removal	13
Oxalis acetosella	Accept*	425
Papaver argemone	Not confined to 1^0 habitats - suggest removal	16
Papaver dubium ssp. lecoqii	Not confined to 1^0 habitats - suggest removal	4
Paris quadrifolia	Retain	5
Parnassia palustris	Retain	7
Pedicularis palustris	Retain	3
Pedicularis sylvatica		55
Persicaria bistorta	Garden escape - suggest removal	216
Persicaria hydropiper	Accept*	390
Petasites hybridus	Reject - not confined to 1^0 habitats	322
Phleum bertolonii		231
Phragmites australis		209
Pimpinella major		151
Pimpinella saxifraga		140

Plantago media		76
Platanthera chlorantha	Retain	21
Poa nemoralis		194
Polygala serpyllifolia		80
Polygala vulgaris		49
Polypodium interjectum	Retain	10
Polypodium vulgare	Accept	171
Polystichum aculeatum		67
Polystichum setiferum	Retain	63
Populus tremula	Accept*	342
Potamogeton berchtoldii	Retain	17
Potamogeton compressus	Retain	4
Potamogeton crispus	Open water species, high N, Suggest removal	81
Potamogeton friesii	Open water species, high N, Suggest removal	8
Potamogeton lucens		13
Potamogeton obtusifolius	Retain	7
Potamogeton pectinatus	Open water species, high N, Suggest removal	158
Potamogeton polygonifolius	Retain	9
Potamogeton pusillus		37
Potentilla anglica		124
Potentilla anserina	Reject - too frequent	560
Potentilla neumanniana		9
Potentilla palustris	Retain	48
Potentilla sterilis	Accept*	355
Potentilla x mixta	Accept	69
Primula veris		205
Primula x polyantha	Retain	21
Prunus padus		210
Puccinellia distans	Reject - not confined to 1^0 habitats	124
Pulicaria dysenterica		121
Quercus petraea	Accept*	303
Ranunculus aquatilis	Open water species, high N, Suggest removal	77
Ranunculus auricomus		77
Ranunculus circinatus	Retain	7
Ranunculus flammula	Accept*	325
Ranunculus fluitans	Open water species, high N, Suggest removal	77
Ranunculus hederaceus		101
Ranunculus lingua		66
Ranunculus omiophyllus		46
Ranunculus parviflorus	Not confined to 1^0 habitats - suggest removal	7
Ranunculus peltatus	Retain	49
Ranunculus penicillatus	Retain	19
Ranunculus sardous	Not confined to 1^0 habitats - suggest removal	11
Ranunculus trichophyllus	Not confined to 1^0 habitats - suggest removal	5
Rhamnus cathartica		29
Rhinanthus minor		172
Ribes alpinum		29
Ribes rubrum	Frequently planted and escaping - Suggest removal	315
Rorippa amphibia		92
Rorippa microphylla	Retain	12

Rorippa palustris		236
Rorippa sylvestris	Not confined to 1^0 habitats - suggest removal	34
Rorippa x sterilis	Retain	13
Rosa caesia	Accept	129
Rosa mollis		24
Rosa x dumalis	Accept	52
Rumex alpinus	Reject - not confined to 1^0 habitats	26
Rumex hydrolapathum	Not confined to 1^0 habitats - suggest removal	247
Rumex maritimus	Open water species, high N, Suggest removal	31
Rumex sanguineus	Reject - not confined to 1^0 habitats and too frequent	585
Sagina apetala	Reject - not confined to 1^0 habitats and too frequent	306
Sagina nodosa	Retain	9
Sagittaria sagittifolia	Not confined to 1^0 habitats - suggest removal	76
Salix aurita		107
Salix pentandra		115
Salix purpurea	Retain	64
Salix repens	Retain	13
Salix x multinervis		75
Sanguisorba minor ssp. minor		46
Sanguisorba officinalis	Retain	277
Sanicula europaea		69
Saxifraga granulata		53
Saxifraga hypnoides		11
Saxifraga tridactylites		30
Scabiosa columbaria		31
Schoenoplectus lacustris		99
Schoenoplectus tabernaemontani	Retain	12
Scirpus sylvaticus	Retain	51
Scleranthus annuus	Not confined to 1^0 habitats - suggest removal	6
Scutellaria galericulata	Not confined to 1^0 habitats - suggest removal	216
Sedum acre	Accept*	273
Sedum telephium		25
Senecio aquaticus		238
Senecio erucifolius		68
Senecio sylvaticus	Retain	120
Senecio x ostenfeldii	Not confined to 1^0 habitats - suggest removal	4
Serratula tinctoria	Retain	17
Sherardia arvensis		65
Silaum silaus	Retain	9
Silene nutans	Retain	4
Solidago virgaurea	Retain	47
Sorbus aria	Reject – planted too frequently	193
Sparganium emersum	Retain	131
Sparganium erectum	Not confined to 1^0 habitats - suggest removal	473
Spergula arvensis	Not confined to 1^0 habitats - suggest removal	235
Spergularia rubra	Not confined to 1^0 habitats - suggest removal	37
Spirodela polyrhiza	Retain	12
Stachys arvensis	Not confined to 1^0 habitats - suggest removal	29
Stachys officinalis		207

Stachys palustris		241
Stachys x ambigua	Usually in 1^0 habitats in Staffs - retain	49
Stellaria holostea	Reject - too frequent	689
Stellaria neglecta	Retain	94
Stellaria uliginosa	Reject - too frequent	475
Succisa pratensis	Accept*	299
Tamus communis	Accept*	416
Teucrium scorodonia	Accept*	386
Thalictrum flavum	Retain	21
Thlaspi arvense	Not confined to 1^0 habitats - suggest removal	101
Tilia cordata		114
Torilis japonica	Possibly include – hedgerow species, even if quite disturbed**	454
Trichophorum germanicum	Retain	16
Trifolium campestre	Retain	282
Trifolium micranthum	Not confined to 1^0 habitats - suggest removal	26
Trifolium striatum	Retain	14
Triglochin palustre		59
Typha angustifolia		54
Ulex gallii	Accept*	301
Vaccinium myrtillus		223
Vaccinium oxycoccos	Retain	17
Vaccinium vitis-idaea		66
Vaccinium x intermedium	Retain	18
Valeriana dioica		73
Valeriana officinalis	Accept*	434
Veronica anagallis-aquatica	Retain	22
Veronica catenata	Retain	68
Veronica hederifolia ssp. hederifolia	Not confined to 1^0 habitats - suggest removal	336
Veronica montana		327
Veronica officinalis		148
Veronica polita	Not confined to 1^0 habitats - suggest removal	24
Viola hirta	Retain	7
Viola lutea	Retain	19
Viola palustris		80
Viola reichenbachiana		56
Zannichellia palustris	Retain	22

KEY

1 occurrence only in habitat-rich TWINSPAN groups – possible axiophyte
Courier text – as above and not on UK axiophytes lists for any county – to be treated with caution
In 2+ of the TWINSPAN groups - strong argument for adding these after further consultation
'TWINSPAN – derived' list agrees with Staffordshire list on BSBI website, which has been consulted on among Flora Group committee members
On Staffordshire list but not TWINSPAN Some species appear to be good axiophytes that the TWINSPAN analysis did not pick up, particularly open water and wetland species

NB the following asterisked species are more common than the current recommended limit for axiophytes, which is species found in fewer than 25% of tetrads (Botanical Society for the British Isles, 2010), the highest number in the current Staffordshire list is 473, which has been used as the upper limit for new suggested axiophytes.

*species in between 25% and 50% of tetrads
**species in over 50% of tetrads and fewer than 473 –
877 tetrads, 25% = 219, 50% = 438.

Figure E1 – Axiophyte richness